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APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1961

OAK RIDGE NATIONAL LABORATORY

operated by

UNION CARBIDE CORPORATION

for the

U.S. ATOMIC ENERGY COMMISSION

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HEALTH PHYSICS DIVISION

APPLIED HEALTH PHYSICS ANNUAL REPORT FOR 1961

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
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for the
U. S. ATOMIC ENERGY COMMISSION

CONTENTS

CONTENTS (con't)

1.0 SUMMARY

The environmental contamination levels observed prior to the arrival of weapons fall-out in September, 1961, were slightly lower than the levels recorded during 1960. After September, 1961, the average contamination level remained several times higher than the level observed during the weapons testing moratorium, 1958-1961. (The French conducted a series of tests in 1960.) The average air concentration level for the Laboratory during 1961 was 0.16% of the $(MPCU)_a$.

Two significant personnel exposures were recorded during the year. One employee received a relatively high "soft" radiation exposure to his left hand. A second employee received a similar exposure to the right hand. During 1961, there were no cases of internal deposition of radioactive materials estimated to average greater than one-third of a permissible amount in the body. As of December 31, 1961, and as the result of an accident which occurred in 1957, only one individual had accumulated a total dose which exceeded the age proration formula, 5(N-18).

During 1961, the Laboratory experienced approximately 75 unusual occurrences of which only two were classified as major. These two incidents resulted in hand exposures as noted above.

2.0 ENVIRONMENTAL MONITORING

Monitoring for air-borne radioactivity incident to the general environment of the East Tennessee area resulting from world-wide weapons testing, AEC operations, etc., is accomplished through the use of three separate monitoring networks. The local air monitoring (LAM) network consists of ten stations which are located within the immediate ORNL area (Fig. 1); the perimeter air monitoring (PAM) network consists of seven stations which encircle the AEC controlled area (Fig. 2); the remote air monitoring (RAM) network consists of eight stations which encircle the Oak Ridge area and are located at distances of from 12 to 120 miles from ORNL (Fig. 3). Monitoring operations include the (1) collection of air-borne radioactivity by passing air continuously through high efficiency filters, (2) collection of fall-out material on gummed paper trays, and (3) collection of rain water for measurement of radioactivity as rain-out. The filter data are representative of radioparticulate matter which might be considered respirable; the gummed paper data are representative of radioparticulate fall-out; and the rain water data, which represents both rain-out and fall-out, provide information on the soluble and insoluble fractions of the radioactive content of fall-out material.

Low level radioactive liquid wastes originating at ORNL are discharged, after preliminary treatment, to White Oak Creek which is a small tributary of the Clinch River. Liquid waste releases are controlled so that resulting average radioactive concentrations in the Clinch River comply with maximum permissible concentrations established for populations in the neighborhood of an atomic energy installation as recommended by the National Committee on Radiation Protection (NCRP).

The radioactive content of White Oak Creek water is determined at a number of points (Fig. 4) along the stream prior to final release to the Clinch River. Water samples are also collected at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river via White Oak Creek and ending at Center's Ferry near Kingston, Tennessee, about 16 miles downstream from the entry of White Oak Creek. These water samples are analyzed for gross radioactivity and for specific long-lived radionuclides contained in the water. Using the maximum permissible concentration values for drinking water, $(MPC)_w$, for each isotope as recommended by NCRP, a weighted average $(MPC)_w$ for the mixture of radionuclides is calculated on the basis of the isotopic distribution in the water. The average concentrations of gross activity are used for control purposes.

Milk and potable water samples are collected at six sampling stations within a radius of 25 miles from the Laboratory. Milk samples are analyzed for Sr-90 and I-131; potable water samples are analyzed for Sr-90. The purpose of this sampling program is twofold: First, samples collected in the immediate Laboratory vicinity provide data to evaluate the possible effect of controlled waste releases originating from the Laboratory on the Sr-90 and I-131 content of milk and potable water of local origin; second, samples collected at more remote locations from the Laboratory area provide background data which is essential in determining the differential increase in contamination due to controlled or accidental releases of significant quantities of Sr-90 and I-131 from Oak Ridge operations.

Current aerial background surveys are necessary for aerial surveying techniques to be of maximum value following a major release of radioactive materials. Aerial background surveys are made at least once each calendar quarter over the Laboratory (ORNL) area (Fig. 5) and for several miles from ORNL in the direction of the prevailing winds. Using light aircraft (Fig. 6) and flying at speeds of approximately 120 miles/hour, experiments have shown that, at an altitude of approximately 300 feet, the equivalent of two times the maximum permissible concentration of I-131 may be detected with reasonable accuracy by scintillation detectors.

Background gamma radiation measurements are made monthly at a number of locations within the Oak Ridge area and less frequently at locations throughout other portions of the East Tennessee area. These measurements are taken with a scintillation type detector at a distance of three feet above the surface of the ground.

Annual surveys have been made of the Clinch and Tennessee Rivers since 1951 in order to evaluate the radioactive content of bottom sediments and to provide data relative to the dispersion of liquid wastes released from the Oak Ridge area.[1]

2.1 Air-borne Radioparticulate Measurements

2.1.1 Concentration as a Function of $(MPCU)_a$[2] - The average concentration of radioactive materials in the air sampled by the LAM network was 1.6×10^{-12} μc/cc, or 0.16% of the $(MPCU)_a$. A slightly lower average value was recorded by the PAM network where the concentration was 1.4×10^{-12} μc/cc or 1.4% of the $(MPCU)_a$. The value obtained by the RAM network was 1.7×10^{-12} μc/cc or 1.7% of the $(MPCU)_a$ which more nearly approximates the LAM averages. (The values derived for concentrations comprising the three networks are shown in Table 1.) The averages recorded during 1961 are approximately four times the levels recorded at the LAM stations during 1960 and about 15 times the levels recorded at the PAM and RAM stations during 1960. The increase observed during 1961 may be attributed to the resumption of weapons testing during September, 1961.

[1] The procedures and techniques used in the river survey program are described in detail in ORNL-2847.

[2] The $(MPCU)_a$ is defined as the maximum permissible concentration for an unknown mixture of radionuclides in air. The $(MPCU)_a$ for occupational exposure is assumed to be 1×10^{-9} μc/cc; the $(MPCU)_a$ for the neighborhood population is assumed to be 1/10 of the occupational exposure. (See NBS Handbook 69, Table 4, p. 94.)

Air-borne radioactivity originating from these tests was first detected in the Oak Ridge area on September 17 and reached a peak (Fig. 7) within the following week (Week No. 39).

2.1.2 Fall-out Measurements - A dramatic increase in radioactive fall-out was noted during September, 1961, on the gummed paper collectors following the resumption of nuclear weapons testing. However, this method of monitoring indicated that the fall-out which began during Week No. 38 in September did not reach a peak until about two months later (Fig. 8) during Week No. 48. Following the peak level observed during Week No. 48, the values dropped sharply during the next five weeks to levels which averaged less than 25% of the peak value. (The number, averaged weekly, of particles per square foot by monitoring network and by station is shown in Table 2.)

The abundance of radioparticulates collected on the air monitor filters was proportional to the concentration of radioactive materials on the filters. Here, the peak occurred in September, Week No. 38, with a general decrease occurring (Fig. 9) for the next seven weeks. The average for December was less than 20% of the peak value shown for September. (The average number of particles per 1000 ft^3 of air sampled for each week is shown in Table 1.)

2.2 Water Analysis

2.2.1 Rain Water - The radioactive content of rain water varied from station to station within each of the three monitoring networks during 1961 but showed only normal variations in pattern. The average concentration observed for each network was as follows:

Network	Concentration (μc/cc)
LAM	1.6×10^{-7}
PAM	2.5×10^{-7}
RAM	4.1×10^{-7}

As observed from the above, the remote stations averaged concentrations that were slightly higher than those observed directly near the Laboratory area. In fact, the highest average concentration observed (Fig. 10) occurred during Week No. 49 at stations located within the RAM network. Prior to September, 1961, the average concentration of radioactive materials in rain water (Fig. 10) was less than 1×10^{-7} μc/cc. (The concentration values for each station are shown in Table 3.)

2.2.2 Clinch River Water - A total of 2228 beta curies was released via White Oak Creek (Table 4) during 1961. Radiochemical analyses of the effluent passing through White Oak Dam indicated that about 89% of the radioactive content consisted of Ru-106 which represented an increase in Ru-106 content of about 11% over the value recorded during 1960. The percentage of Sr-90 decreased from 2.5% in 1960 to 1.2% in 1961.

The calculated average concentration of mixed fission products in the Clinch River at Clinch River Mile (CRM) 20.8 (the point of entry of White Oak Creek into the river) was 7.8×10^{-7} μc/cc (Table 5). The calculated value was based on the fission product curie content of water released via White Oak Creek to the river and the dilution factor afforded by the river.

Assuming uniform mixing of White Oak Creek and Clinch River waters, the calculated average radioactive content of Clinch River water during 1961 at CRM 20.8 was 18% of the $(MPC)_w$ recommended for persons who make up the population in the neighborhood of a controlled area. The average concentration of radioactivity in water taken from the Clinch River above the entry of White Oak Creek (Table 5) at CRM 33.2 was about 0.74% of the $(MPC)_w$. The calculated $(MPC)_w$ value was exceeded in the river at CRM 20.8 (by only 2%) during one week of the year (Fig. 11) and occurred as the result of a reduction of flow from Norris Dam and the attendant loss of dilution in the Clinch River at the point of entry of White Oak Creek.

The average concentration of mixed fission products in the Clinch River at CRM 4.5 (near Kingston, Tennessee) was 3.5×10^{-7} μc/cc. This value is 7.1% (Table 5) of the weighted average maximum permissible concentration for drinking water for populations in the neighborhood of a controlled area.

2.2.3 Potable Water - Potable water samples are collected within a radius of 25 miles of the Laboratory. The average concentration of Sr-90 in the samples processed in the latter part of 1961 was 0.3 μμc/liter which represents 0.3% of the average permissible concentration for drinking water used by persons residing in the neighborhood of a controlled area. The above value does not differ significantly from data published by the U. S. Public Health Service concerning other parts of the USA.

2.3 Milk Analyses

The average concentration of Sr-90 in the milk samples collected from within a 25-mile radius of the Laboratory was 11 μμc/liter. The average concentration of I-131 was 8 μμc/liter. A comparison of the amount of Sr-90 and I-131 in samples processed at ORNL with five other locations within the United States[3] is shown in Fig. 12. Assuming a maximum permissible concentration of 100 μμc/liter for Sr-90 and 50 μμc/liter for I-131, the Sr-90 content for milk would have been about 11% of the assumed maximum permissible value; the I-131 content would have been about 16% of the assumed maximum permissible value.[4]

[3] Report by the U. S. Public Health Service, Vol. III, No. 1, Jan., 1962.

[4] The assumed maximum permissible values are based on an intake of 1 liter of milk per day and assumes that half of the Sr-90/I-131 intake results from milk consumption.

2.4 Background Measurements

2.4.1 Aerial Surveys - The background readings in the East Tennessee area determined by aerial survey techniques are on the order of 5 μr/hr. Typical chart recordings taken on flights over the Laboratory area for the years 1958 through 1961 are shown in Fig. 13.

2.4.2 Ground Surveys - During the last quarter of 1961, a number of background measurement stations were established in the East Tennessee area along the routes to the remote air monitoring stations. Background measurements were taken during routine servicing visits to the remote air monitoring stations and at least one station was visited each week. Background readings and the location of each station are shown in Fig. 14. The average background reading for the 4th quarter of 1961 was on the order of 15 μr/hr.

Since 1950, background counts have been taken once each month at approximately 50 stations located on the Laboratory site. The counts, when corrected to mr/hr, have varied from a low of 0.08 mr/hr recorded in 1950 to a high of 0.28 mr/hr recorded in 1952. The average for 1961 (Fig. 15) was slightly less than 0.1 mr/hr.

During 1961 a satisfactory method for moisture-proofing radiation monitoring films was developed and moisture-proof packets were placed at points near the 50 local stations where background checks by counting methods are made normally. The films were collected and processed each quarter. For the last quarter of 1961, the average reading determined by the film technique differed by less than 10% from counting techniques. The film technique provides for continuous background monitoring and will be used exclusively for on-site background monitoring starting at the beginning of the next calendar year.

Background readings made monthly at five selected off-area stations yielded an average background reading during 1961 (Fig.15) of slightly less than 0.02 mr/hr; the value is slightly less than twice the average background of 0.012 mr/hr measured in the Oak Ridge area in 1943 prior to the start-up of the X-10 Graphite Reactor and does not differ significantly from averages observed throughout the eastern section of the United States.

2.5 Annual Survey of the Clinch and Tennessee Rivers

The 1961 survey of the Tennessee River extended downstream through Kentucky Reservoir to Tennessee River Mile (TRM) 24.6 which is approximately two miles upstream from Kentucky Dam.

Figures 16 and 17 show the gamma radiation count rate observed on river bottom sediment for the years 1952, 1960, and 1961. The 1952 survey[5] is the only previous survey that extended to the mouth of the

[5] J. M. Garner and O. W. Kochtitzky, "Radioactive Sediments in the Tennessee River System", Journal of the Sanitary Engineering Division of the American Society of Civil Engineers, Vol. 82, No. SA2, August, 1956.

Tennessee River and the data are presented here for comparison with the 1961 survey in the lower reaches of the Tennessee. The 1961 count is considerably less than the 1960 level at all points in both the Clinch and Tennessee Rivers. The 1961 level was greater generally than the 1952 level in the Clinch and Tennessee Rivers as far downstream as Hales Bar Dam. The average gamma count rate levels for Guntersville, Wheeler, Wilson, and Pickwick Reservoirs do not vary appreciably from each other. The 1961 level is less than the 1952 level at all points in Kentucky Reservoir.

The reading over bottom sediment at the location of maximum contamination is shown in Fig. 18. The average gamma count rate for the 11-year period, 1951 through 1961, is shown for the Clinch and the Tennessee Rivers in Fig. 19.

Radiochemical analyses of river silt collected in the 1960 and 1961 surveys are given in Tables 6 and 7. During 1961, and for the first time since the surveys were initiated, Ru-106 replaced Cs-137 as the principal radioactive component found in river silt. The concentration of most of the radioactive isotopes found in river silt decreased with distance downstream from the point of entry of the wastes, approaching background levels near the mouth of the Tennessee River. However, Ru-106 and Sr-90 remained above background levels throughout the Kentucky Reservoir. (Silt taken from Fort Loudoun Reservoir was used to approximate "background" levels.)

3.0 PERSONNEL MONITORING

It is the policy of Oak Ridge National Laboratory to monitor the radiation exposure of each individual who enters the Laboratory premises to ensure (1) that personnel exposure is kept to the lowest practical level within permissible limits and (2) to provide a record of any radiation exposure sustained by individuals as the result of Laboratory operations. Personnel monitoring is accomplished by means of personnel meters, personnel contamination surveys, analysis of body fluids, and in vivo gamma counting techniques.

The principal personnel meter for monitoring accumulated external exposure is the ORNL Badge-Meter-Model II (Fig. 20) which is both a combination radiation exposure meter and security identification badge. This particular badge meter is issued to all individuals who are assigned to work at the Laboratory for an extended period of time. Individuals who visit the Laboratory for short periods of time are issued a temporary security pass (Fig. 21) which contains a monitoring film packet shielded over one area by a thickness of indium foil.

In addition to the film meter (Fig. 22), pocket-type ionization chambers (pocket meters) are provided individuals who work in areas where the dose rate and working time is such as to result in an accumulated exposure of 20 mrem or more in a single work day. Also, other personnel meters are issued for special job assignments and exposure conditions when the film meter and/or pocket meter alone will not provide the necessary degree of exposure control required for the exposure record.

Although administrative procedures, zoning techniques, and special work equipment are used to effect control over the radioactive contamination of personnel, internal dose measurements are made routinely from body fluids analysis at a frequency determined by the exposure potential in the work area where personnel are assigned. The frequency of sampling ranges from about once each month for those individuals who work routinely with radioisotopes to once every three years for persons whose potential for exposure to internal emitters is highly limited or even unlikely. Whole body counting techniques are employed when applicable.

3.1 External Exposures

During 1961, two employees received hand exposures which exceeded the values recommended by the Federal Radiation Council (FRC) and consisted primarily of beta radiation. One employee sustained a skin dose of approximately 1200 rem to the thumb and forefinger of his left hand. A second employee sustained an exposure of approximately 300 rem to the thumb and forefinger of the right hand. The highest whole body external dose sustained by an employee was about 6 rem or 50% of the maximum permissible annual dose. Only three employees received whole body external exposures greater than the maximum permissible yearly average of 5 rem.

As of December 31, 1961, the highest single cumulative dose of radiation sustained by an employee was approximately 77.4 rem. The ten highest cumulative radiation doses (Table 8) ranged downward from the high of approximately 77.4 rem to approximately 53.2 rem. During 1961, 99.85% of all Laboratory personnel (Table 10) sustained exposures of less than 1/3 of the maximum permissible annual dose of 12 rem.

As of December 31, 1961 (Table 9), only one Laboratory employee had accumulated a dose of whole body radiation which exceeded the age proration formula 5(N-18). Almost all of this dose resulted from an accident which occurred during 1957 and, at the end of 1961, represented about 150% of the dose permitted by the age proration formula 5(N-18). Less than 1% of the Laboratory population (Table 11) had sustained a cumulative exposure in excess of 50% of the dose permitted by the age proration formula 5(N-18).

3.2 Internal Exposures

During 1961, there were no cases where the deposition of radioactive materials within the body was estimated to have averaged greater than 1/3 of a maximum permissible body burden.

3.3 Monitoring Resume

3.3.1 Pocket Meters - The number of readable pocket meters processed during 1961 totaled 340,889 (Table 12) which represented an increase of about 10% over 1960. The number of paired off-scale readings (above 200 mrem)[6] decreased by more than 50% while there was a statistical probability of about 10^{-5} that two "leakers" would be paired randomly prior to issuance.

3.3.2 Film Meters - The total number of monitoring films processed during 1961 was 92,644 (Table 12) which differed by about 1% from the number processed during 1960.

3.3.3 Bio-Assays - A total of 4723 analyses (Table 13) was performed by the Bio-Assays Unit during 1961. Of this number, about 75% included gross alpha or Sr-90 analyses.

3.3.4 Whole Body Counter[7] - The scheduling of personnel for examination by whole body counting techniques was directed primarily toward investigating known or suspected internal contamination exposures. A total of 142 whole body counts was made on 102 people. Of these, 12 persons showed measurable amounts of activity (Table 14) other than normal K-40 and Cs-137 content.

3.3.5 Laundry Monitoring - About 8% of the 445,000 garments monitored by the Laundry Monitoring Unit was found to be above maximum permissible operating limits.

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[6] When paired off-scale readings occur, the film badge meter is processed to establish the true dose.

[7] Data provided by the Health Physics Technology Section.

4.0 LABORATORY OPERATIONS MONITORING

The Applied Health Physics Annual Report for 1959 (ORNL-3073) established certain ground rules for classifying radiation accidents, or near accidents, and the term "unusual occurrence" was adopted to describe these events. Following the publication of ORNL-3073, the definition of the unusual occurrence was gradually expanded to include one or more of the following circumstances:

1. A violation of a Health Physics regulatory policy.

2. An event which might have resulted in significant personnel exposure or facility contamination under less fortunate circumstances.

3. An event which might have had public relations significance under less fortunate circumstances.

4. A quarterly dose in excess of permissible limits or a single event dose in excess of 1/3 of the quarterly limit.

5. Radiation or contamination incident of a magnitude sufficient to result in a significant suspension of operations.

An unusual occurrence is considered to be a <u>major event</u> when (1) an individual sustains a radiation dose in excess of permissible limits as recommended by the NCRP or FRC, (2) Laboratory operations result in the contamination of the environment surrounding the Laboratory area in excess of levels recommended by the NCRP or the FRC, and (3) the cost of reclaiming a laboratory facility following a radiation incident exceeds $5000. All other unusual occurrences are considered to be <u>minor events</u>.

4.1 Unusual Occurrences

The Laboratory sustained 75 unusual occurrences during 1961. Two of the unusual occurrences were classified as major events (Table 15, Part II) and in both cases involved hand exposures to beta radiation. In one instance an employee received an exposure to the thumb and forefinger of the right hand which was estimated to be about four times the permissible annual dose to the extremities. No clinically observable effects were recorded. In the second instance, an employee sustained beta burns over portions of the left hand and fingers which was estimated to be at least 16 times the permissible annual dose.

The total number of unusual occurrences decreased over the number experienced during 1960 (Table 15, Part I) by about 12%. However, the main significant difference between the unusual occurrences recorded during 1960 and 1961 is reflected in the number of contamination events (Table 15, Part III) where a decrease of about 30% was observed during 1961. This decrease is generally attributed to an accelerated health physics program within the operating areas and a gradual implementation of the containment program.

There does not appear to be any significant change in the source of unusual occurrences (Table 16) when reviewed by operating divisions. The same is true of work facilities (Table 17) except for the case of ORNL units at the Y-12 site and in Bldg. 3019 facilities at ORNL. The number dropped slightly in Y-12 operations during 1961 largely due to the fact that certain operations were curtailed. During both years, operations carried out in Bldg. 3019 facilities were involved in more radiation events than were operations carried out in any other facility with an increase in the number of events over 1960 of about 7%. It should be noted that this increase parallels an increase in operational activities.

There has always been a feeling that radiation events tend to occur toward the end of the work week. Perhaps this feeling stems from the fact that staff personnel are frequently required to work over into the weekend hours when a radiation event occurs on Friday. The data show (Table 18) that fewer events tend to occur on Thursday and that the frequency of incidents is not limited to any other particular day of the week except for a sizable decrease on Saturday and Sunday when operations are minimal.

5.0 ASSAYS AND INSTRUMENTS

5.1 Counting Facility

During 1961, 577,199 samples (Table 19) were processed through the counting room for an average of 10,890 samples per week. This represents a decrease of about 10% over the total processed in 1960 and was due, in part, to a reduction in the number of contamination smear samples processed during clean-up activities in Bldg. 3019.

5.2 Health Physics Instrumentation

The Instrumentation and Controls Division is responsible for the development of health physics instruments, recommending specific makes for purchase, and for performing maintenance on health physics instruments. The Applied Health Physics Section recommends the type and quantity of health physics instruments used at ORNL.

During 1961, the following types of instruments were developed or tested as a cooperative effort between the Health Physics and Instrumentation and Controls Divisions:

1. A portable fast-neutron survey meter, ORNL Q-2047, was tested and approved for procurement in quantity. The detector used is a non-directional tissue equivalent type. The meter utilizes transistorized components and is powered by Ni-Cd cells.[8]

2. A transistorized, 12-volt battery powered, portable, decade scaler for GM counter operation was fabricated and tested for use in stream surveys.[8]

3. A continuous alpha air monitor (ORNL Q-2340) used in the detection of medium to higher levels of air-borne alpha activity was designed, tested, and approved for procurement in quantity.[8]

4. A preliminary design of a fall-out monitor was completed. A prototype for testing will be completed during 1962.

5.3 Calibrations Facility

Approximately 4450 portable survey-type instruments were calibrated during 1961; in addition, 6309 films were calibrated for various source materials. The total number of calibrations performed during 1961 (Table 20) differed only slightly from the number recorded for 1960.

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[8] For a detailed description see Health Physics Instruments, ORNL-332 (1961 Ed.).

6.0 PUBLICATIONS AND REPORTS

6.1 Publications

H. H. Abee, J. C. Hart, "A Proportional Liquid Effluent Sampler for Large-Volume Flows", American Industrial Hygiene Association Journal, Vol. 22, April, 1961.

D. M. Davis, J. C. Hart, A. D. Warden, "Radiation Dose Received by Passengers and Crew on Planes Carrying the Maximum Number of Radiation Units", American Industrial Hygiene Association Journal, Vol. 22, December, 1961.

E. D. Gupton, "Personnel Monitoring", Nuclear Safety, Vol. 3, No. 1, September, 1961.

E. D. Gupton, D. M. Davis, J. C. Hart, "Criticality Accident Application of the Oak Ridge National Laboratory Badge Dosimeter", Health Physics, Pergamon Press 1961, Vol. 5, pp. 57-62.

W. T. Thornton, D. M. Davis, E. D. Gupton, "The ORNL Badge Dosimeter and Its Personnel Monitoring Applications", ORNL-3026.

6.2 Interdepartmental Reports

Monthly:

(a) Radioactivity in Clinch River Water

Quarterly:

(a) Environmental Levels of Radioactivity in the Oak Ridge Area

(b) Applied Health Physics Quarterly Report

(c) Summary of Bio-assay Analysis

(d) Summary of Personnel Monitoring Data

7.0 TABLES

TABLE 1 CONCENTRATION OF RADIOACTIVE MATERIALS IN AIR - 1961
(Averaged Weekly from Filter Paper Data)

Station Number	Location	Long-Lived Activity 10^{-13} μc/cc	No. of Particles by Activity Ranges[a] $< 10^5$ d/24 hr	10^5-10^6 d/24 hr	10^6-10^7 d/24 hr	$> 10^7$ d/24 hr	Total	Particles Per 1000 ft^3
Laboratory Area								
HP-1	S 3587	16	92	1.4	0.19	0.06	94	2.3
HP-2	S 3001	17	92	1.4	0.19	0.00	94	2.7
HP-3	S 1000	16	103	1.9	0.21	0.06	105	1.7
HP-4	W 3513	12	94	1.4	0.17	0.04	96	1.7
HP-5	E 2506	22	114	1.6	0.25	0.00	116	4.0
HP-6	SE 3012	15	146	1.7	0.15	0.00	148	2.7
HP-7	W 7001	16	124	1.7	0.11	0.00	125	2.7
HP-8	Rock Quarry	13	107	1.2	0.09	0.04	108	2.0
HP-9	N Bethel Valley Rd.	12	132	1.3	0.08	0.06	133	2.1
HP-10	W 2075	17	92	1.8	0.08	0.15	94	2.2
Average		16	110	1.5	0.15	0.04	111	2.4
Perimeter Area								
HP-11	Kerr Hollow Gate	14	118	1.5	0.08	0.00	119	2.4
HP-12	Midway Gate	15	140	1.4	0.19	0.02	142	2.8
HP-13	Gallaher Gate	14	137	2.0	0.06	0.04	140	2.8
HP-14	White Wing Gate	13	138	1.8	0.09	0.00	140	2.8
HP-15	Blair Gate	16	128	1.6	0.04	0.00	130	2.6
HP-16	Turnpike Gate	14	123	1.4	0.06	0.00	124	2.4
HP-17	Hickory Creek Bend	15	110	1.6	0.11	0.00	112	2.2
Average		14	128	1.6	0.09	0.01	129	2.6
Remote Area								
HP-19	Norris Dam	16	134	1.7	0.08	0.00	136	2.4
HP-20	Loudoun Dam	17	116	2.2	0.07	0.00	118	2.1
HP-21	Douglas Dam	17	154	2.1	0.11	0.00	156	2.8
HP-22	Cherokee Dam	16	117	1.3	0.11	0.02	118	2.1
HP-23	Watts Bar Dam	19	132	1.8	0.06	0.02	134	2.4
HP-24	Great Falls Dam	19	158	1.8	0.06	0.00	159	2.8
HP-25	Dale Hollow Dam	14	175	1.0	0.00	0.00	176	3.1
HP-26	Berea, Kentucky	13	121	0.9	0.00	0.00	122	2.4
Average		17	138	1.7	0.08	0.01	140	2.5

[a] Determined by continuous air monitor.

TABLE 2 RADIOPARTICULATE FALL-OUT - 1961

(Averaged Weekly from Gummed Paper Data)

Station Number	Location	Long-Lived Activity 10^{-4} μc/ft^2	No. of Particles by Activity Ranges $< 10^5$ d/24 hr	10^5-10^6 d/24 hr	10^6-10^7 d/24 hr	$> 10^7$ d/24 hr	Total Particles Per Sq. ft.
			Laboratory Area				
HP-1	S 3587	4.7	22	0.9	0.06	0.00	23
HP-2	S 3001	6.0	33	1.2	0.06	0.02	34
HP-3	S 1000	3.6	19	0.5	0.00	0.00	20
HP-4	W 3513	4.4	22	0.5	0.04	0.04	22
HP-5	E 2506	4.4	30	0.7	0.04	0.00	31
HP-6	SE 3012	5.3	45	0.6	0.08	0.00	46
HP-7	W 7001	4.2	25	0.6	0.00	0.00	25
HP-8	Rock Quarry	3.5	25	0.4	0.00	0.00	26
HP-9	N Bethel Valley Rd.	3.5	20	0.4	0.06	0.00	20
HP-10	W 2075	6.2	45	0.8	0.04	0.04	46
Average		4.6	29	0.7	0.04	0.01	29
			Perimeter Area				
HP-11	Kerr Hollow Gate	4.9	21	0.5	0.06	0.00	22
HP-12	Midway Gate	4.9	26	0.5	0.00	0.00	26
HP-13	Gallaher Gate	3.4	19	0.6	0.02	0.00	20
HP-14	White Wing Gate	3.1	19	0.4	0.00	0.00	21
HP-15	Blair Gate	4.0	21	0.3	0.02	0.00	21
HP-16	Turnpike Gate	4.2	21	0.5	0.04	0.00	22
HP-17	Hickory Creek Bend	4.0	23	0.6	0.02	0.04	24
Average		4.1	22	0.5	0.02	0.01	22
			Remote Area				
HP-19	Norris Dam	2.9	14	0.3	0.06	0.02	14
HP-20	Loudoun Dam	3.6	12	0.4	0.06	0.00	12
HP-21	Douglas Dam	3.0	11	0.5	0.02	0.00	11
HP-22	Cherokee Dam	3.3	13	0.5	0.02	0.00	14
HP-23	Watts Bar Dam	2.8	13	0.4	0.02	0.00	14
HP-24	Great Falls Dam	4.7	16	0.4	0.00	0.00	17
HP-25	Dale Hollow Dam	4.2	16	0.5	0.04	0.00	16
HP-26	Berea, Kentucky	2.8	9	0.5	0.02	0.00	10
Average		3.4	13	0.4	0.03	0.00	13

TABLE 3 CONCENTRATION OF RADIOACTIVE MATERIALS IN RAIN WATER - 1961
(Averaged Weekly by Stations)

Station Number	Location	Activity in Collected Rain Water, μc/cc
	Laboratory Area	
HP-7	West 7001	1.6×10^{-7}
	Perimeter Area	
HP-11	Kerr Hollow Gate	2.1×10^{-7}
HP-12	Midway Gate	2.9
HP-13	Gallaher Gate	3.0
HP-14	White Wing Gate	2.4
HP-15	Blair Gate	2.2
HP-16	Turnpike Gate	2.6
HP-17	Hickory Creek Bend	2.2
Average		2.5×10^{-7}
	Remote Area	
HP-19	Norris Dam	4.8×10^{-7}
HP-20	Loudoun Dam	2.6
HP-21	Douglas Dam	5.1
HP-22	Cherokee Dam	3.3
HP-23	Watts Bar Dam	4.8
HP-24	Great Falls Dam	5.3
HP-25	Dale Hollow Dam	3.4
HP-26	Berea, Kentucky	3.2
Average		4.1×10^{-7}

Note: Total rainfall in 1961 was 54.94 inches, a deviation of + 4.9 % from the normal rainfall of 52.38 inches.

TABLE 4 LIQUID WASTE DISCHARGED FROM WHITE OAK CREEK, 1961

	Total for Year	Weekly Average	% Deviation from 1960 Weekly Average
Beta curies	2228	42	0
Pu and other trans-uranic Alpha Emitters			
10^{-9} μc/cc		5.0	-96.4*
millicuries	68	1.3	-64.3*

* 1960 data were accumulated in units of μg/cc and milligrams total. These data were converted to μc/cc and millicuries total, based on Pu^{239}, for comparison with 1961 data.

TABLE 5 RADIOACTIVE CONTENT OF CLINCH RIVER - 1961

Location	Concentration of Nuclides of Primary Concern in Units of 10^{-8} μc/cc					Average Concentration of Total Radioactivity	$(MPC)_w^a$	
	Sr^{90}	Ce^{144}	Cs^{137}	$Ru^{103-106}$	Co^{60}	10^{-8} μc/cc	10^{-6} μc/cc	% of $(MPC)_w$
Clinch River								
Mi. 33.2	0.07	0.07	0.05	0.5	0.04	0.65	0.88	0.74
Mi. 20.8[b]	0.56	0.08	0.32	36	0.60	78	4.3	18
Mi. 4.5	0.43	0.10	0.05	28	0.39	35	4.9	7.1

a Weighted average $(MPC)_w$ calculated for the mixture, using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

b Values given for this location are calculated values based on the levels of waste released and the dilution afforded by the river.

c Center's Ferry (near Kingston, Tennessee just above entry of the Emory River).

TABLE 6 RADIONUCLIDES IN RIVER SILT - 1960-1961

(Units of 10^{-6} μc/g of Dried Mud)

		Cs (as $Cs-Ba^{137}$)		Ce (as $Ce-Pr^{144}$)		Sr (as Sr^{90})		Co (as Co^{60})		Ru (as $Ru-Rh^{106}$)		Zr + Nb (as $Zr-Nb^{95}$)		TRE* + Y^{90} (as Y^{90})	
		1960	1961	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961	1960	1961
CRM	21.5	1.5	1.3	0.8	0.44		0.26	0.5	0.32	1.8	2.7	0.7	0.50	1.4	0.7
	19.1	64	41	9.0	2.7	0.7	1.0	8.2	5.9	27	95	1.0	1.4	23	7.8
	16.3	175	71	23	5.6	2.3	2.0	19	11	80	159	3.6	1.7	74	16
	15.2	374	64	39	4.4	4.4	0.77	35	10	83	148	2.9	1.8	144	16
	14.0	257	127	25	8.2	2.7	1.1	27	14	99	153	5.6	1.8	132	31
	11.0	240	98	34	9.4	3.7	1.0	25	14	99	144	14	4.6	177	29
	8.0	194	81	25	9.4	3.5	1.4	22	11	85	152	9.8	2.3	144	26
	5.8	177	115	22	9.9	2.6	1.0	22	14	90	157	5.8	2.7	69	28
	4.7	176	112	18	9.9	1.4	1.3	21	15	79	148	1.9	2.7	38	20
	2.6	93	82	11	7.0	1.0	0.90	12	11	72	103	3.4	1.1	72	23
	1.1	141	100	11	8.6	1.4	0.41	16	12	55	141	4.2	1.8	48	35
Average		172	81	19	6.9	2.4	0.85	19	11	70	128	4.8	2.0	81	21
TRM	570.8	1.5	1.1	0.9	0.72	0.2	0.14	0.3	0.36	2.7	2.7	0.9	0.72	0.5	1.1
	562.7	46	34	3.1	2.9	0.5	0.49	6.0	4.5	19	34	2.3	1.2	21	8.2
	552.7	32	42	1.8	2.9	0.5	0.59	5.0	5.3	17	39	1.4	1.4	12	5.7
	543.8	28	15	2.3	1.1	0.5	0.27	4.7	2.5	14	22	1.3	1.1	8.6	3.1
	532.0	24	25	1.8	2.3	0.7	0.63	4.1	3.9	13	31	2.3	0.86	5.1	4.0
	509.5	**	1.1	**	0.23	**	0.27	**	0.6	**	8.6	**	0.36	**	1.2
	491.9	18	14	1.8	1.8	0.9	0.36	3.6	3.0	27	30	2.3	0.72	5.0	3.2
	471.1	11	11	1.0	1.5	0.4	0.36	2.3	2.4	10	26	1.4	0.77	3.1	3.4
	434.1	10	4.5	1.6	1.1	0.5	0.36	2.7	1.3	32	28	2.1	0.45	3.0	1.5
	381.2	6.3	3.5	1.3	0.76	0.5	0.72	1.4	1.0	12	14	1.5	0.77	0.9	1.4
	354.4	4.0	4.6	0.6	0.95	0.5	0.36	1.4	1.1	6.9	13	1.2	0.77	2.0	1.9
Average		18	14	1.6	1.5	0.5	0.41	3.2	2.4	15	23	1.7	0.83	6.1	3.2

* Tl^{204} was used as a reference standard for tri-valent rare earth fraction.

** No samples collected at this location in 1960.

TABLE 7 RADIONUCLIDES IN RIVER SILT DOWNSTREAM FROM TRM 337.6 - 1961[a]

(Units of 10^{-6} $\mu c/g$)

Sample Location		Cs (as $Cs\text{-}Ba^{137}$)	Ce (as $Ce\text{-}Pr^{144}$)	Sr (as Sr^{90})	Co (as Co^{60})	Ru (as $Ru\text{-}Rh^{106}$)	Zr + Nb (as $Zr\text{-}Nb^{96}$)	Tri-valent TRE + Y^{90} (as Y^{90})
TRM	337.6	0.45	0.27	0.32	0.23	4.1	0.68	0.54
	320.9	2.5	0.77	0.09	0.41	11	0.68	0.86
	280.0	4.6	1.5	0.36	0.90	16	0.72	0.68
	267.4	4.8	1.8	0.54	0.90	18	0.77	1.6
	261.3	6.9	2.4	0.45	1.2	25	1.1	1.8
	227.4	2.0	0.90	0.31	0.72	8.7	0.63	0.72
	207.3	2.6	0.99	0.23	0.81	12	0.59	1.0
	97.2	1.1	0.54	0.45	0.45	7.2	0.54	0.86
	75.7	0.99	0.68	0.18	0.41	6.4	0.68	0.32
	67.0	0.90	0.50	0.23	0.32	5.0	0.59	1.1
	45.8	0.99	0.86	0.18	0.41	5.3	0.54	0.77
	24.6	1.2	0.86	0.41	0.41	4.4	0.59	0.54
Av.		2.4	1.0	0.31	0.60	10	0.68	0.90
Fort Loudoun Background Data								
FL. A		1.2	0.77	0.14	0.36	1.9	0.72	0.86
FL. B		0.99	0.99	0.18	0.32	2.3	0.68	1.4
Av.		1.1	0.88	0.16	0.34	2.1	0.70	1.1

[a] No silt collected in this section of the Tennessee River in 1960.

TABLE 8 PERTINENT DATA REGARDING THE TEN LABORATORY EMPLOYEES WHO HAVE SUSTAINED THE HIGHEST CUMULATIVE DOSE OF PENETRATING RADIATION AS OF DECEMBER 31, 1961

Employee	Department or Division	Age	Tenure of Employment (years)	Dose (rem)
1	Isotopes	42	17	77.4
2	Isotopes	43	14	70.8
3	E and M	27	9	67.5
4	Isotopes	55	17	67.2
5	Isotopes	54	16	64.8
6	Isotopes	37	18	61.5
7	Isotopes	33	9	54.2
8	Operations	43	18	54.0
9	Isotopes	30	10	53.6
10	Isotopes	36	15	53.2

TABLE 9 PERTINENT DATA REGARDING THE TEN EMPLOYEES WHO HAVE SUSTAINED THE HIGHEST EXPOSURE BASED ON THE AGE FORMULA 5(N-18) (Note: Employees I, II, IV, V, VI, VIII, and IX are also listed in Table 8.)

Employee	Department or Division	Age	Tenure of Employment (years)	% MPAD 5(N-18)
I (3)	E and M	27	9	150
II (9)	Isotopes	30	10	89
III	Isotopes	31	12	73
IV (7)	Isotopes	33	9	72
V (6)	Isotopes	37	18	65
VI (1)	Isotopes	42	17	65
VII	Isotopes	34	11	62
VIII (10)	Isotopes	36	15	59
IX (2)	Isotopes	43	14	57
X	I and C	31	10	54

TABLE 10 DOSE DATA SUMMARY FOR LABORATORY POPULATION INVOLVING EXPOSURE TO PENETRATING RADIATION DURING 1961

Dose Range (rem)	Number of Employees	Percentage of Population
0 - 1.0	4057	95.93
1.1 - 2.0	141	3.33
2.1 - 3.0	17	0.40
3.1 - 4.0	8	0.19
4.1 - 5.0	2	0.05
5.1 - 6.0	2	0.05
6.1 - 7.0	2	0.05
Above 7	0	0
TOTALS	4229	100.00

TABLE 11 DOSE DATA SUMMARY FOR LABORATORY POPULATION, DECEMBER 31, 1961, INVOLVING CUMULATIVE EXPOSURE PENETRATING RADIATION AS BASED ON THE AGE PRORATION FORMULA 5(N-18)

Dose Range % 5(N-18)	Number of Employees	Percentage of Population
0 - 10.0	3972	93.93
10.1 - 20.0	160	3.78
20.1 - 30.0	57	1.35
30.1 - 40.0	22	0.52
40.1 - 50.0	6	0.14
50.1 - 60.0	5	0.12
60.1 - 70.0	3	0.07
70.1 - 80.0	2	0.05
80.1 - 90.0	1	0.02
90.1 -100.0	0	0.00
100.1 -150	1	0.02
TOTALS	4229	100.00

TABLE 12 PERSONNEL METER DISTRIBUTION AND PERFORMANCE DATA

A. Pocket Meters

(1)	Meters distributed	341,107
(2)	Readable meters	340,889
(3)	Non-readable meters	218
(4)	Non-readable pairs	0
(5)	Off-scale readings	989
(6)	Off-scale pairs	81

B. Film Meters

(1) Processing data

(a)	Film badge meters (record)	22,292
(b)	Film badge meters (non-record)	173
(c)	Film meters (Temp. pass)	32,384
(d)	Hand meters, special packets, etc.	7,785
(e)	Neutron films developed (not read)	16,191
(f)	Neutron films developed (read)	4,309
(g)	Films for non-ORNL groups	3,047
(h)	Calibrations (beta gamma)	5,471
(i)	Special X-ray films	1,165
(j)	Total Films Handled	92,644

(2) Data loss

(a)	Dosimeter damaged (dose not interpretable)	31
(b)	Dosimeter lost (replacement issued)	70
(c)	Dosimeter not turned in (not lost)	88

TABLE 13 BIO-ASSAYS ANALYSES, 1961

Determinations for this period	Number of Analyses	Highest Sample d/m/24 hours
Urine:		
Cs^{137}	39	790
Gα	1687	13
H^{3}	76	2.0×10^{8}
P^{32}	10	5.8×10^{3}
Pa^{233}	14	12
Po^{210}	11	3.4
Pu^{239}	35	1.3
Ra	4	0.4
Sr^{89}	4	120
Sr^{90}	1318	1.4×10^{4}
TRE (Total Rare Earths)	233	1.9×10^{3}
U	612	160
Miscellaneous	32	--
Fecal:		
Gα	74	--
Sr^{90}	1	--
Others*	573	--
TOTAL	4723	

Summary:
Number of samples greater than 100 per cent of the limiting value - 33
Number of times three successive samples exceeded 25 per cent of the limiting value - 20

* Analyses performed on specimens from employees of other installations.

TABLE 14 MEASURABLE ACTIVITY FOUND IN 12 EXPOSURE SUSPECTS - 1961[a]

Isotope	Persons With Above Normal Activity	Highest Activity Measured (μc)
Cs^{137}	3	0.36
Zr^{95} - Nb^{95}	1	0.011
Sb^{125}	5	0.162
Ru^{106} - Rn^{106}	3	0.131
Co^{60}	4	0.013
Ce^{144} (+ Pr^{154})	1	0.03
Co^{58}	3	0.02
Fe^{59}	3	0.04
Cr^{51}	3	0.32
I^{131}	4	0.20
Zn^{65}	1	0.04
Hg^{203}	1	0.5×10^{-6}

[a]Data provided by Health Physics Technology Section.

TABLE 15 UNUSUAL OCCURRENCES SUMMARIZED (1960-1961)

		Number Recorded 1961	1960
	I. General		
1.	Events involving personnel exposure below MPE limits and requiring little or no clean-up effort.	34	27
2.	Events involving personnel exposure above MPE limits and/or requiring special clean-up effort.	41	60
	Total	75	87
	II. Personnel Exposures		
3.	Exposures in excess of operational MPE limits of no major consequence constituting a minor event with short-term work restrictions imposed.	5	9
4.	Exposures in excess of MPE limits sufficient to qualify as a major event with work restrictions imposed.	2	1
	Total	7	10
	III. Area Contamination		
5.	Events handled by the regular work staff with no appreciable program loss.	37	56
6.	Events requiring interdepartmental assistance with minor departmental program loss.	3	2
7.	Events resulting in halting or temporarily deterring parts of the Laboratory program.	0	1
	Total	40	59

TABLE 16 UNUSUAL OCCURRENCES CLASSIFIED ACCORDING TO DIVISIONAL RESPONSIBILITY - 1961

Division Responsible	Event Number	Operating Facility	Number Recorded 1961	Number Recorded 1960
Analytical Chemistry	9	Bldg. 4501 (R-219)	3	4
	72	3019 (HRLAF)		
	75	3019 (HRLAF)		
Biology	20	Bldg. 9207 (Rm. 307-A)	1	2
Chemical Technology	1	Bldg. 3019 (Cells 6 and 7)	19	17
	2	3019 (Penthouse)		
	4	3019 (Cells 6 and 7)		
	6	3019		
	7	3019 (Cell 5)		
	16	3019 (Cell 3)		
	21	3019 (Penthouse)		
	23	3505		
	26	3019 (Cell 2)		
	27	3019 (Cell 2)		
	29	3019 (Cell 3)		
	31	4507 (SW Corner)		
	39	4501 (Rm. BS74)		
	44*	3508		
	47	3019 (Cell 2)		
	50	3019 (Penthouse)		
	63	3019 (Rm. 100)		
	68	3019 (Pipe Tunnel)		
	69	4507 (Cell 4)		
Chemistry	17	Bldg. 4500 (Lab D-9)	2	3
	48	4501 (Rm. 118)		
Engineering and Mechanical	44*	Bldg. 3508	4	5
	45	Burial Ground #5		
	53	Burial Ground #5		
	54	Burial Ground #5		
Electronuclear Research	8	Bldg. 9201-2	7	5
	12	9201-2		
	13	9201-2		
	32	9201-2		
	51	9201-2		
	55	9201-2		
	57	9201-2		
Isotopes	11	Bldg. 3026 (Lab 8)	9	14
	22	3517 (Cell 15)		
	34	3517		
	36	3031		
	43	3028		
	49	3029 (E Shed)		
	66	3028E		
	71	3517 (Cell 16)		
	74	3038 (Street Area)		

*Responsibility Shared by Other Division(s)

TABLE 16 (Con't)

Division Responsible	Event Number	Operating Facility	Number Recorded 1961	1960
Metals and Ceramics	5	Bldg. 2005 and 2024	5	3
	18	4501 (Rm. 127)		
	40	2000 (Rm. 11)		
	56	2024 (Rm. 41)		
	59	4501 (Rm. 127)		
Neutron Physics	58	Bldg. 3001 (Rm. 107)	3	2
	64	9213 (E Test Cell)		
	67	9213 (Rm. 201)		
Operations	19	Bldg. 3005 (LITR)	12	14
	24	3042		
	28	3042 (S Hot Cell)		
	33	3001 (SW Corner)		
	38	3026-D (Cell B-2)		
	41	3042		
	52	3026-D (Cell A)		
	60	3025 (Hot Cells Access)		
	61	3042		
	62	3042		
	65	3025 (Hot Cells Access)		
	73	3005 (Street Area)		
Physics	35	Bldg. 4500 (Lab H-19)	1	0
Reactor	3	Bldg. 7500 and 3019 (HRLAF)	7	11
	10	7500		
	14	7500 (E High Bay Area)		
	15	7500 (Crane Bay Area)		
	25	7500 (E Storage Pool)		
	30	7500 (Hot Tool Storage)		
	46	7500		
Reactor Chemistry	42	Bldg. 9204-1 (100A Loop Area)	1	1
Thermonuclear	37	Bldg. 9201-2	1	0
Off Site	70	Roadway Express Terminal Knoxville, Tennessee	1	0

TABLE 17 UNUSUAL OCCURRENCES CLASSIFIED ACCORDING TO THE FACILITIES IN WHICH THEY OCCUR (1960-1961)

Building or Facility	Number Recorded 1961	1960
Bldg. # 2000	1	2
2001	0	1
2005	1	0
2007	0	1
2024	1	0
2528	1	0
3001	2	3
3005	1	4
3012	0	1
3019	16	11
3025	2	3
3026-C	1	2
3026-D	2	0
3028	2	2
3029	1	2
3031	1	0
3033	0	1
3042	5	3
3044	0	1
3500	0	1
3505	1	0
3508	1	2
3517	2	6
3550	0	1
4500	2	2
4501	5	3
4507	2	0
7500	2	5
9201-2	8	4
9204-1	1	6
9204-3	0	4
9207	1	2
9213	2	2
9733-3	0	1
Miscellaneous		
Burial Ground No. 4	0	2
Burial Ground No. 5	3	2
NW of Bridge to 7500	0	1
Street Area at 3005	1	0
Street Area at 3038	1	0
Central Avenue	0	2
Chestnut Ridge	0	1
7500 Roadway	0	1
South Side of Bldg. 4500	0	1
Roadway Express Terminal, Knoxville	1	0

TABLE 18 UNUSUAL OCCURRENCES BY DAY OF WEEK INVOLVED (1960-1961)

Day of the Week Involved	Number Recorded 1961	1960	Percentage 1961	1960
Sunday	6	3	8.0	3.5
Monday	14	14	18.6	16.1
Tuesday	13	15	17.4	17.2
Wednesday	14	16	18.6	18.4
Thursday	9	11	12.0	12.6
Friday	15	19	20.0	21.8
Saturday	4	9	5.4	10.4
Total	75	87		

TABLE 19 COUNTING SERVICES PERFORMED, 1961

Type of Sample	Calculations	Number of Samples			Total	Weekly Average
		Alpha	Beta	Gamma		
Smears		214886	246230		461116	8700.3
Air Samples	38324	35628	35429		109381	2063.8
Area Monitoring		421	6247		6668	125.8
Sanitary Engineering		14	14		28	.5
Gamma Spectrometry				6	6	.1
TOTAL	38324	250949	287920	6	577199	10890.5

TABLE 20 CALIBRATIONS RESUME, 1961

Type Instrument	Total No. of Calibrations
Cutie Pie	1,576
Juno	105
Samson	29
GM Survey Meter	1,392
Dosimeters	747
Portable Scintillation, Alpha	33
Monitrons	83*
Films	6,309
Miscellaneous	213
PGA	272
TOTAL	10,759

* Cs^{137} sources issued to survey offices for calibration of monitrons. This unit now does much less routine monitron calibration.

8.0 FIGURES

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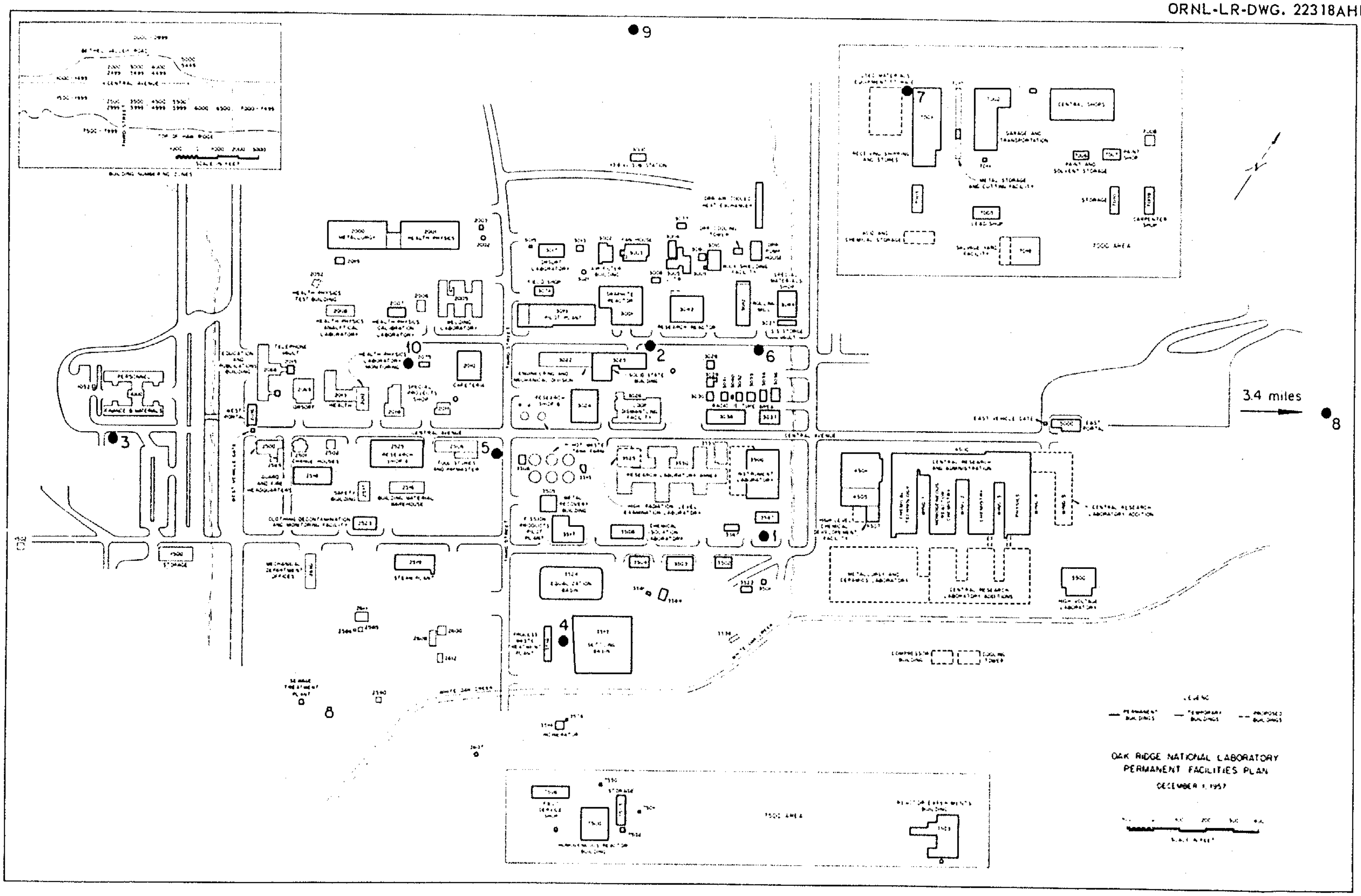

Fig. 1. Laboratory Area Showing the Approximate Location (•) of the Local Monitoring Stations Constituting the LAM Network.

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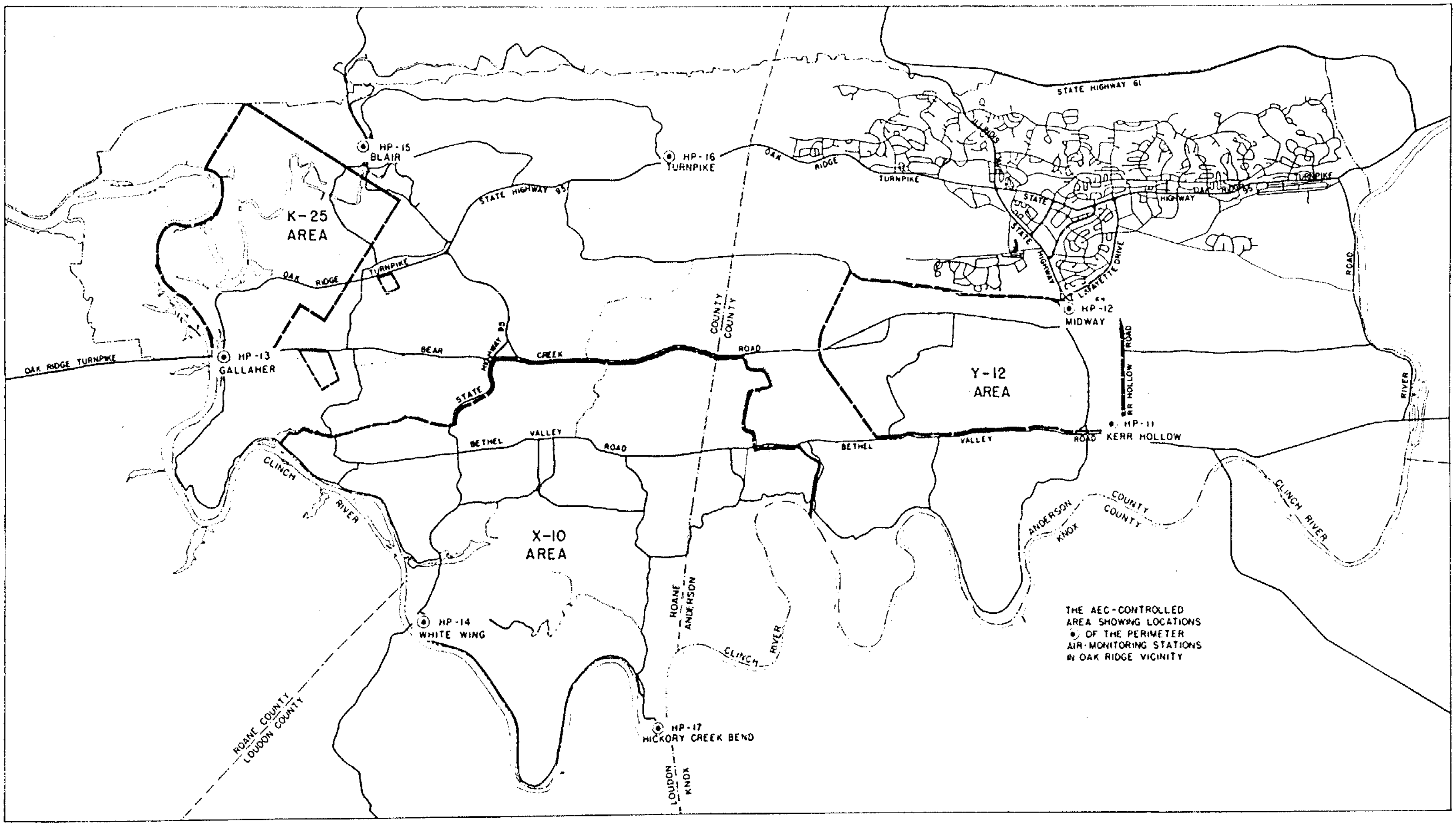

Fig. 2. AEC Controlled Area and Vicinity Showing the Approximate Location (◉) of the Perimeter Air Monitoring Stations Constituting the PAM Network.

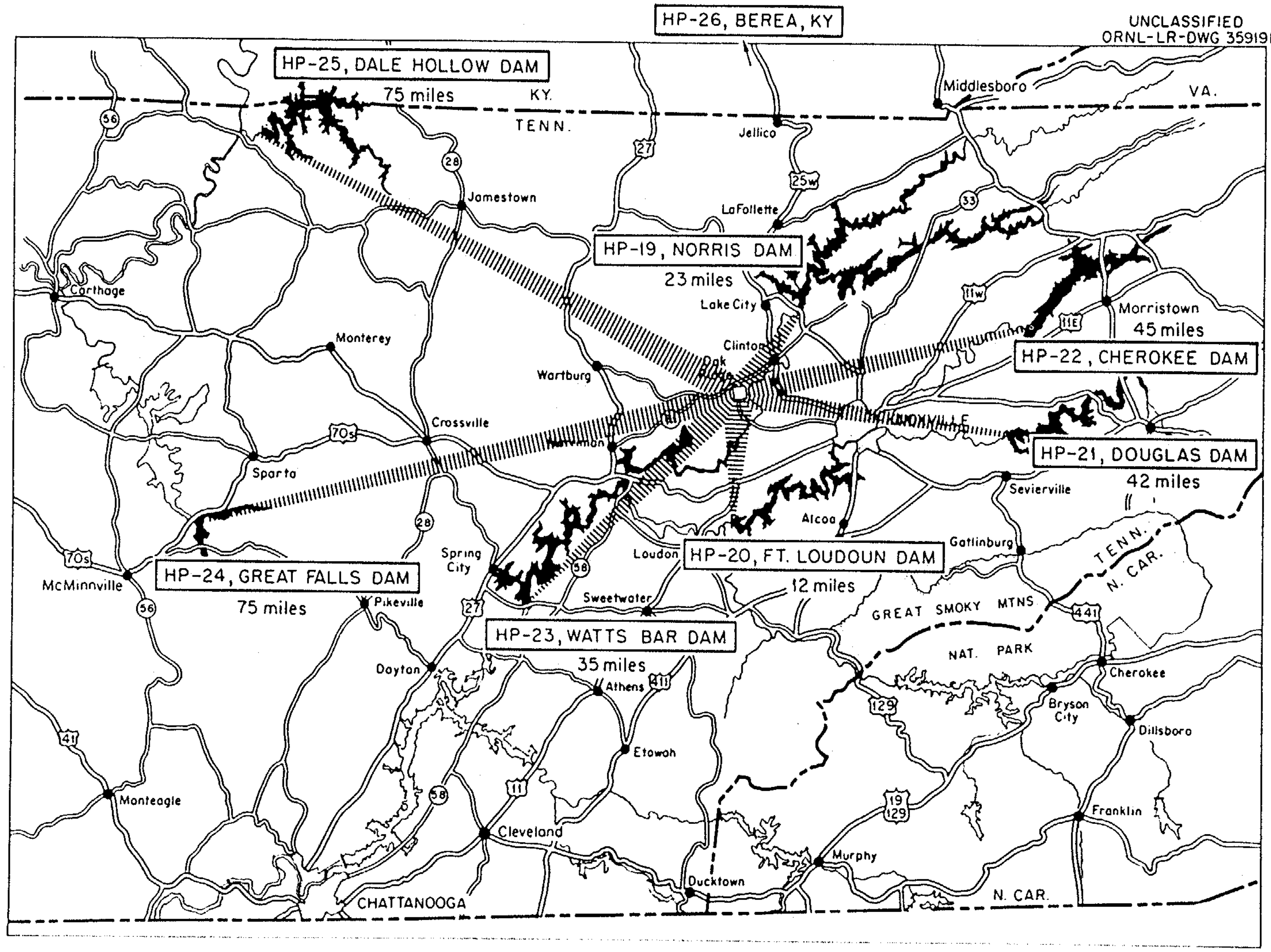

Fig. 3. East Tennessee Area Showing TVA and U.S. Corps of Eng. Dam Sites at Which Are Located the Remote Air Monitoring Stations Constituting the RAM Network.

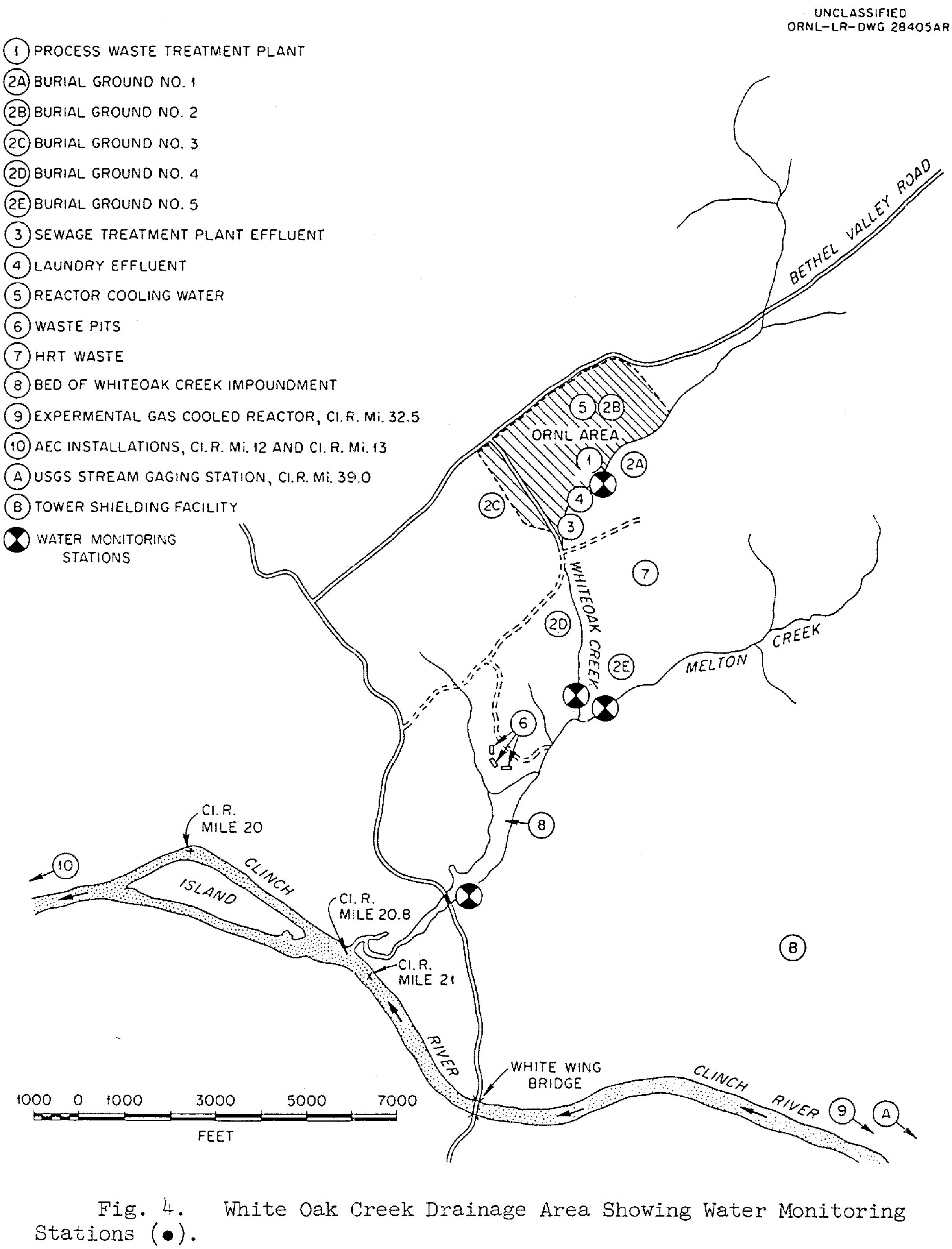

Fig. 4. White Oak Creek Drainage Area Showing Water Monitoring Stations (●).

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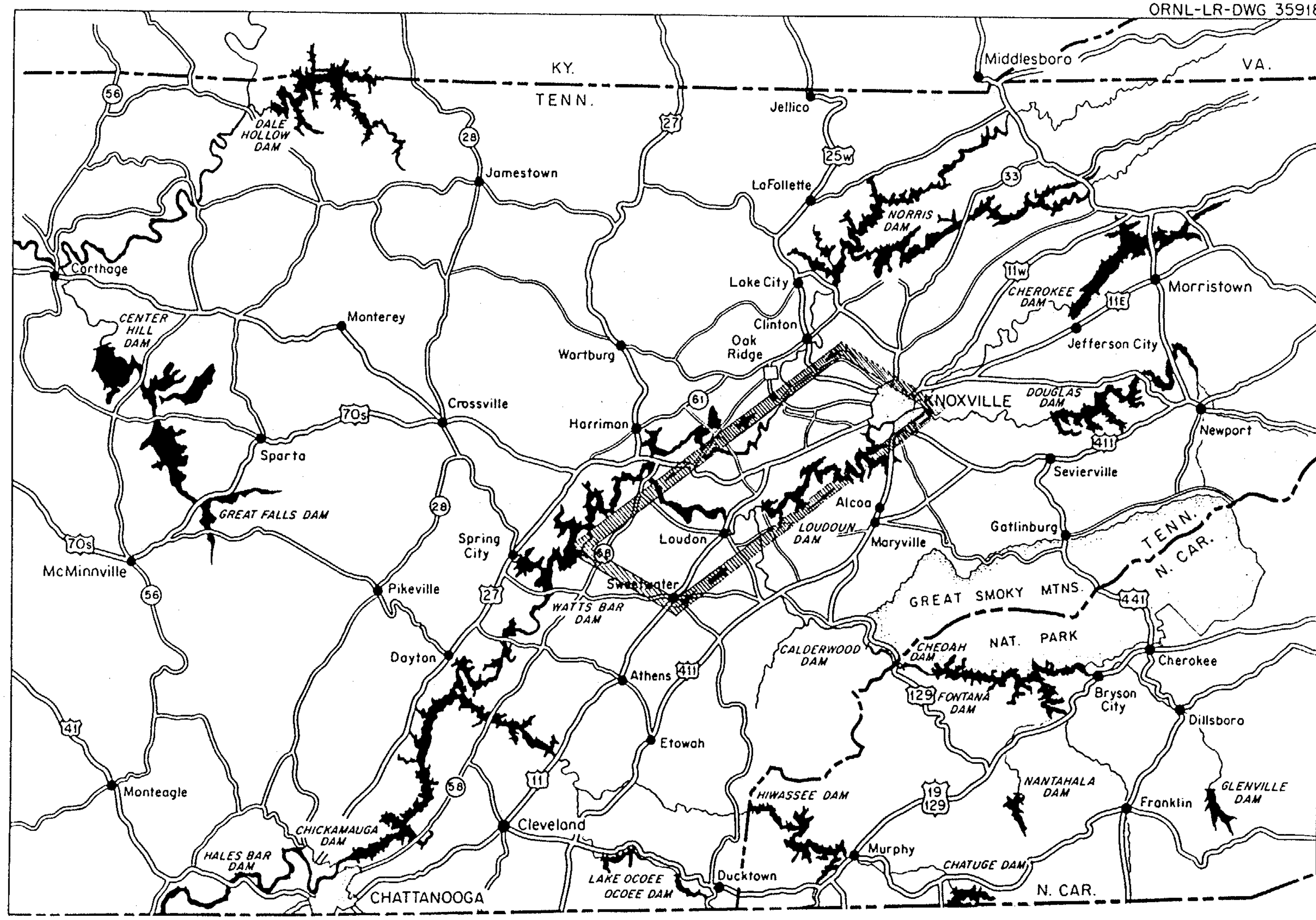

Fig. 5. Pattern Flown with Light Aircraft During Aerial Background Survey.

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Fig. 6. Light Aircraft Used for Routine Aerial Surveys.

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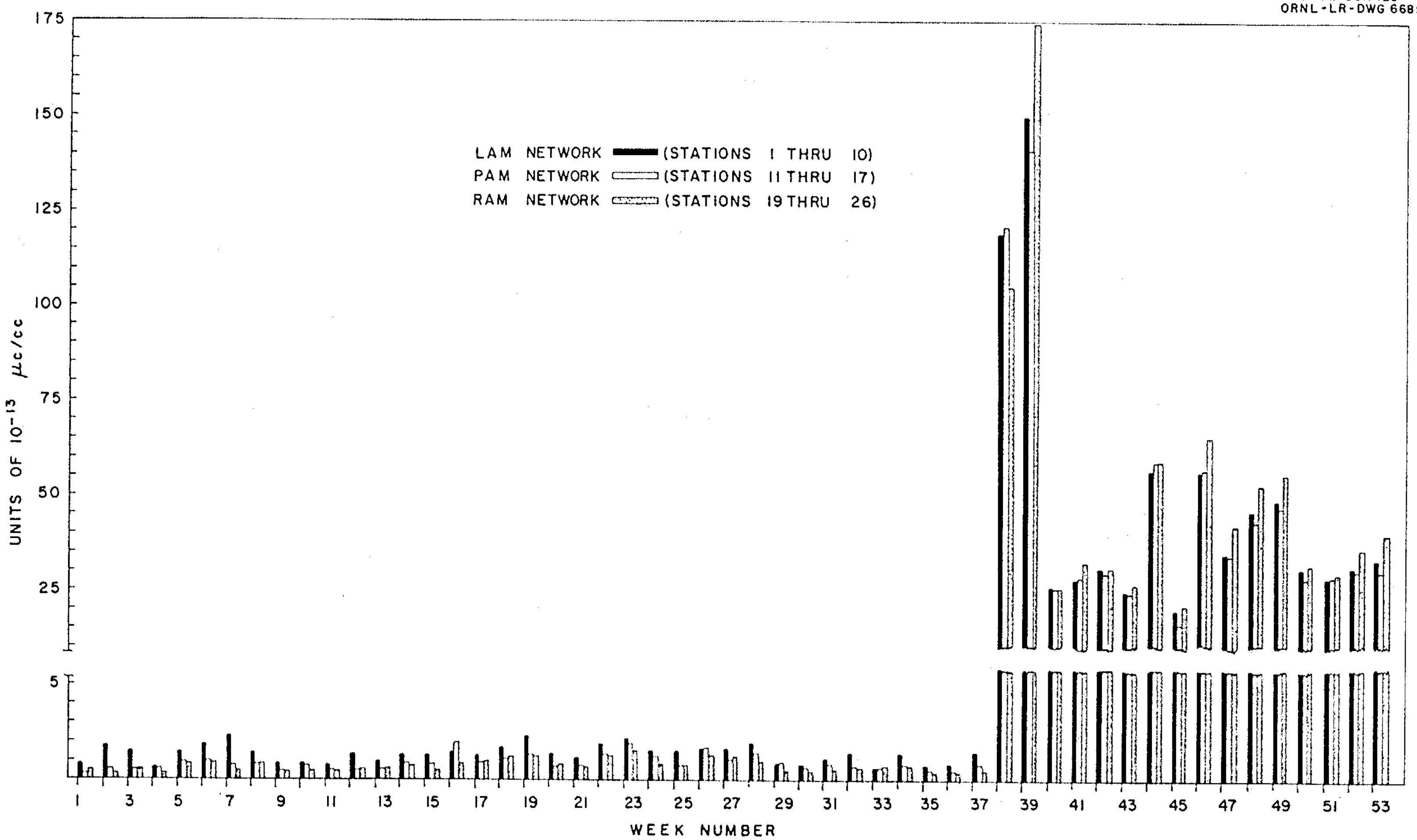

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Fig. 7. Concentration of Radioactive Materials in Air as Determined from Filter Paper Data, 1961.

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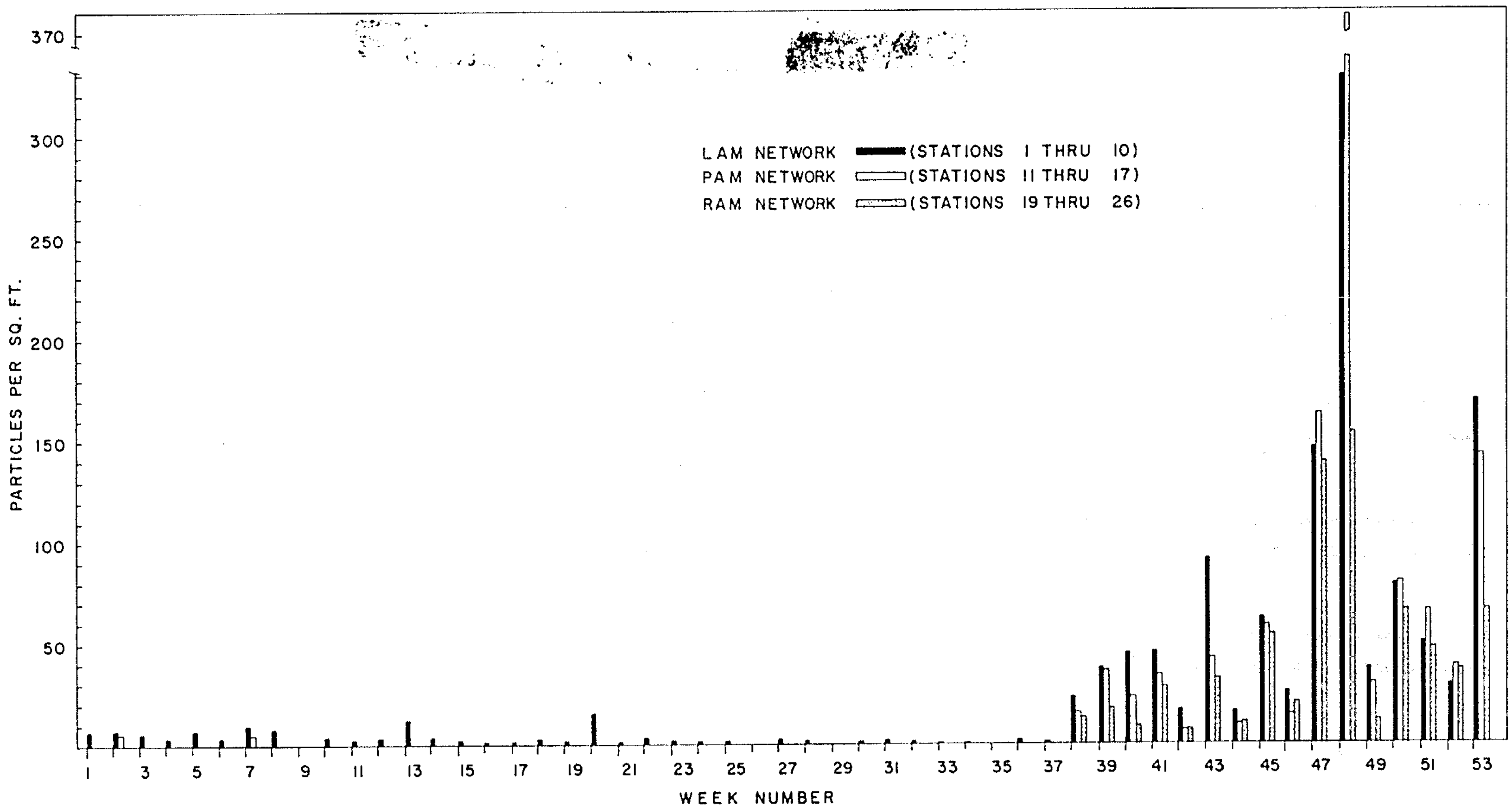

Fig. 8. Radioparticulate Fall-Out Measurements as Determined by Autoradiographic Techniques Using Gummed Paper Collectors, 1961.

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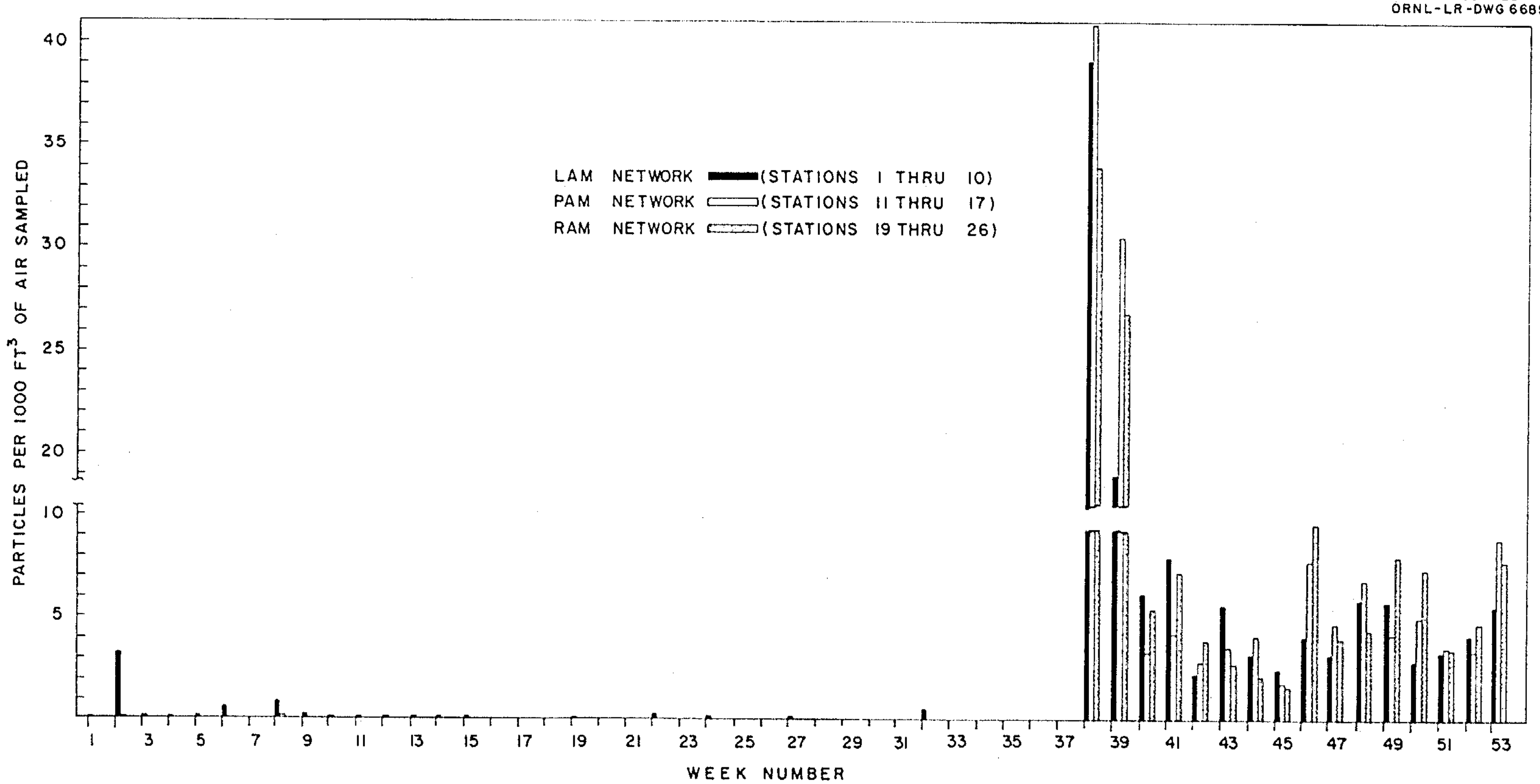

Fig. 9. Radioparticulate Fall-Out Measurements as Determined by Autoradiographic Techniques Using Filters from Continuous Air Monitors, 1961.

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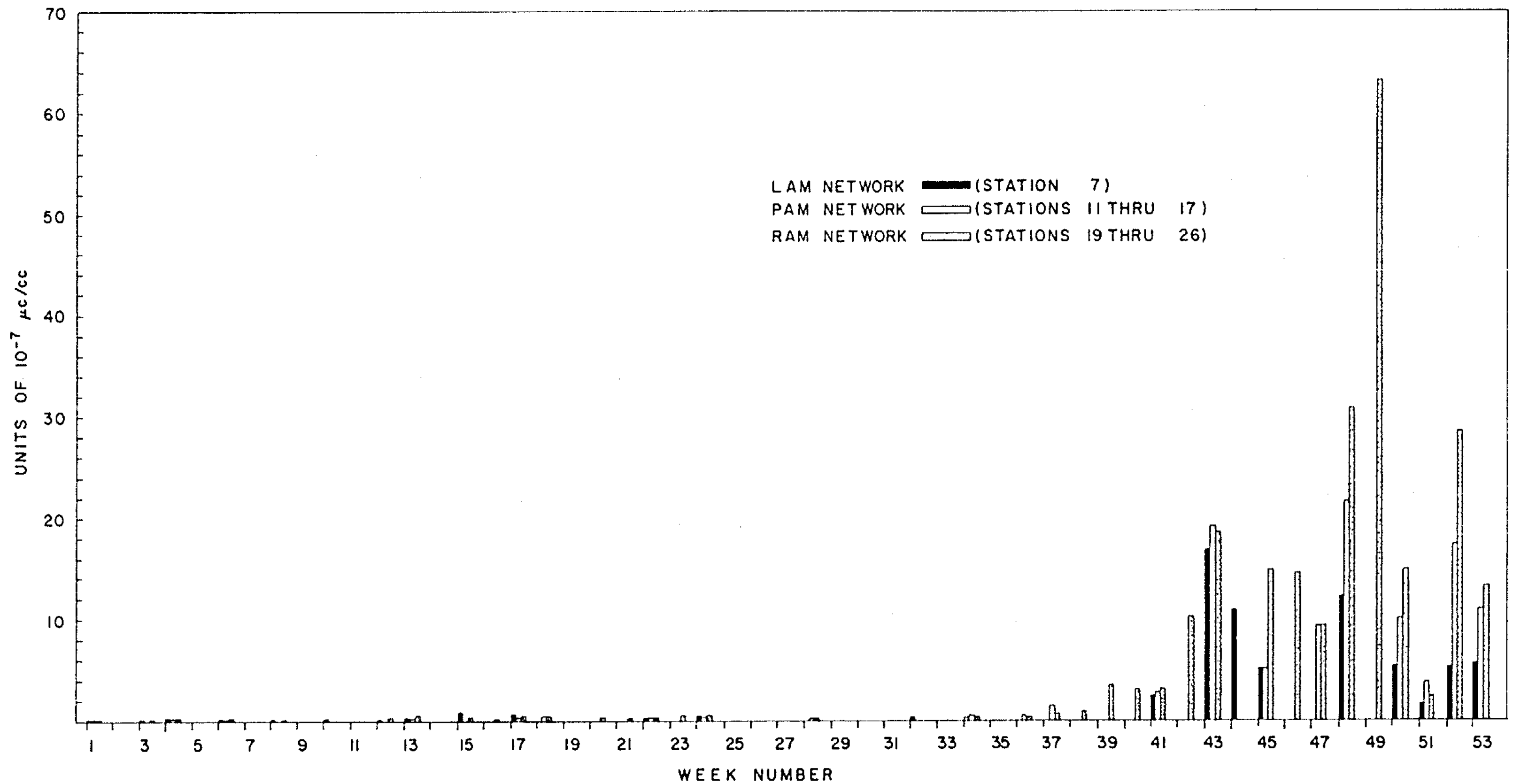

Fig. 10. Concentration of Radioactive Material in Rain Water, 1961.

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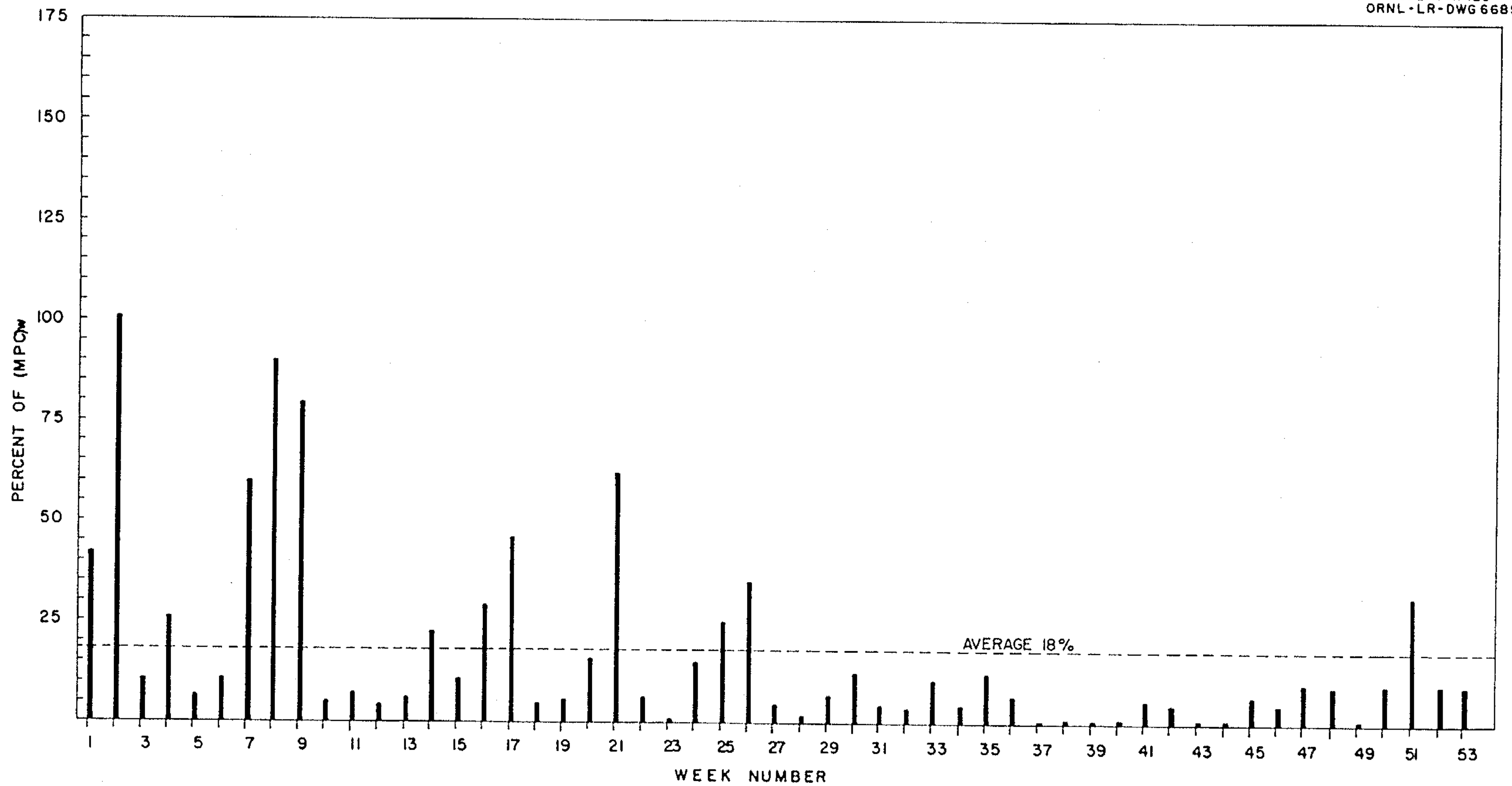

Fig. 11. Estimated Per Cent $(MPC)_w$ of Clinch River Water below the Mouth of White Oak Creek, 1961.

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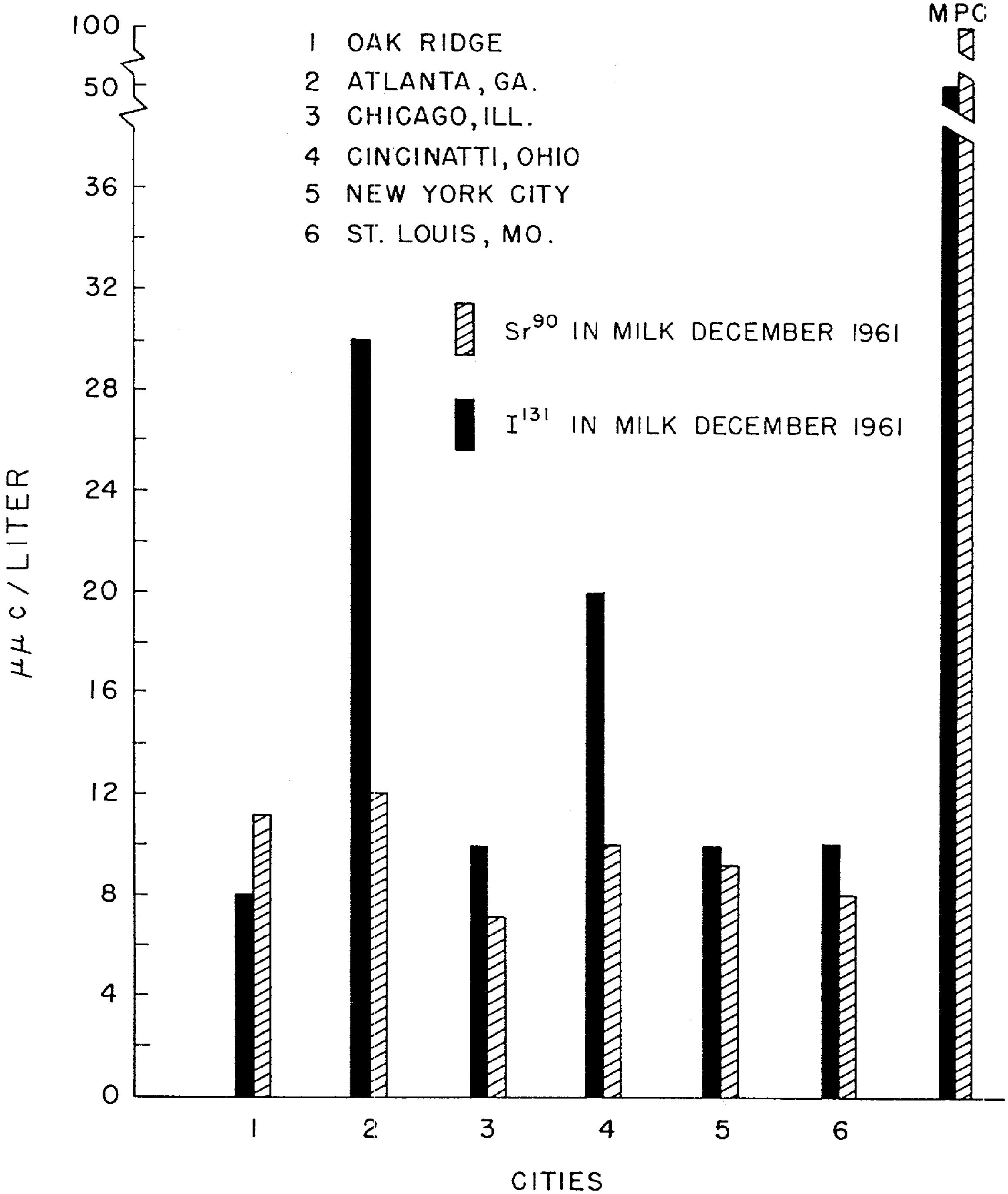

Fig. 12. Sr^{90} and I^{131} Content in Milk Produced in the Oak Ridge Area Compared to Milk Produced in Other Sections of the U. S., 1961. (Data from other sections taken from report by USPHS, Vol. III, No. 1, Jan., 1962.)

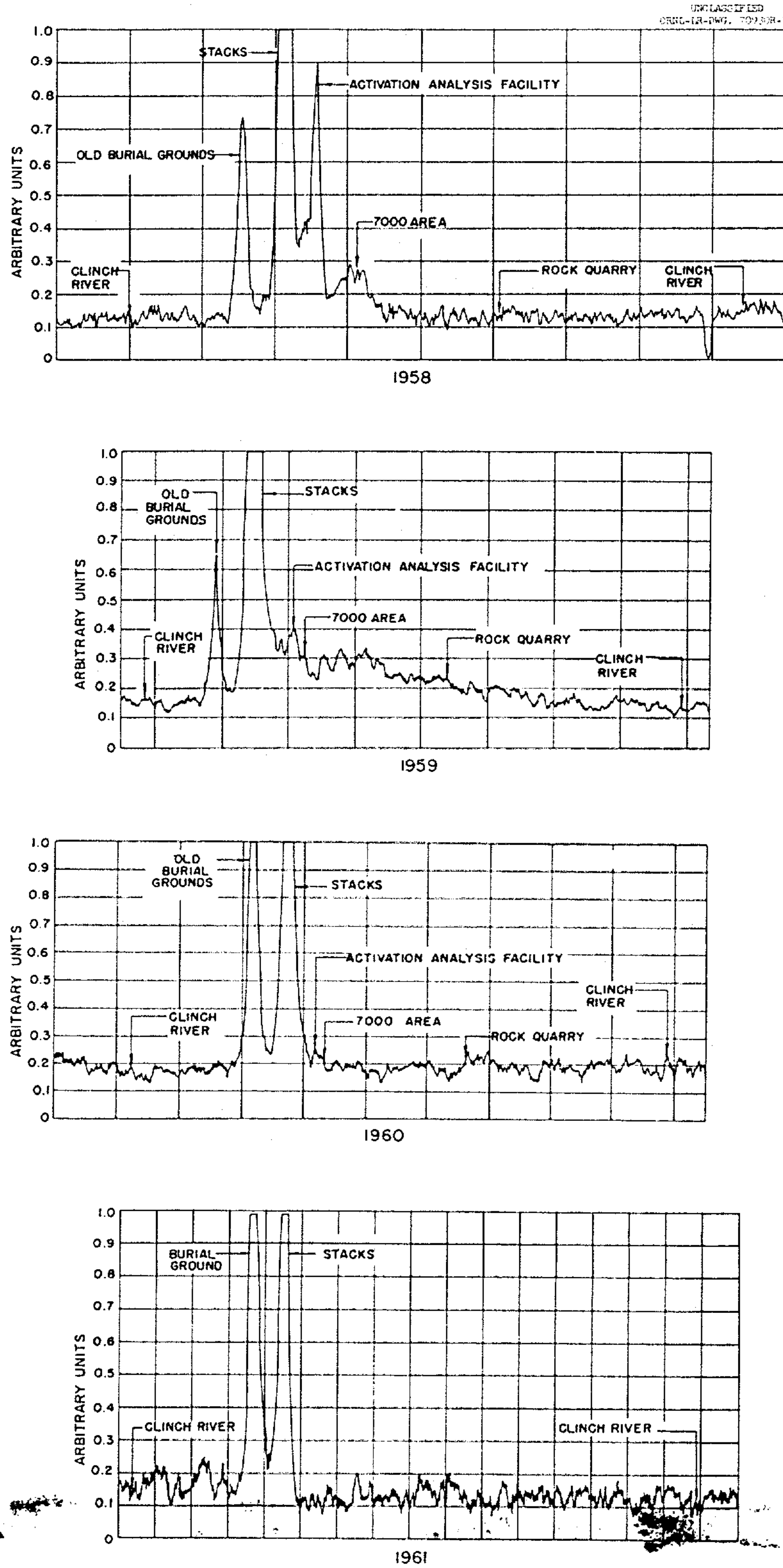

Fig. 13. Radiation Background Profile of the ORNL Area as Determined by Aerial Survey Techniques, 1958-1961.

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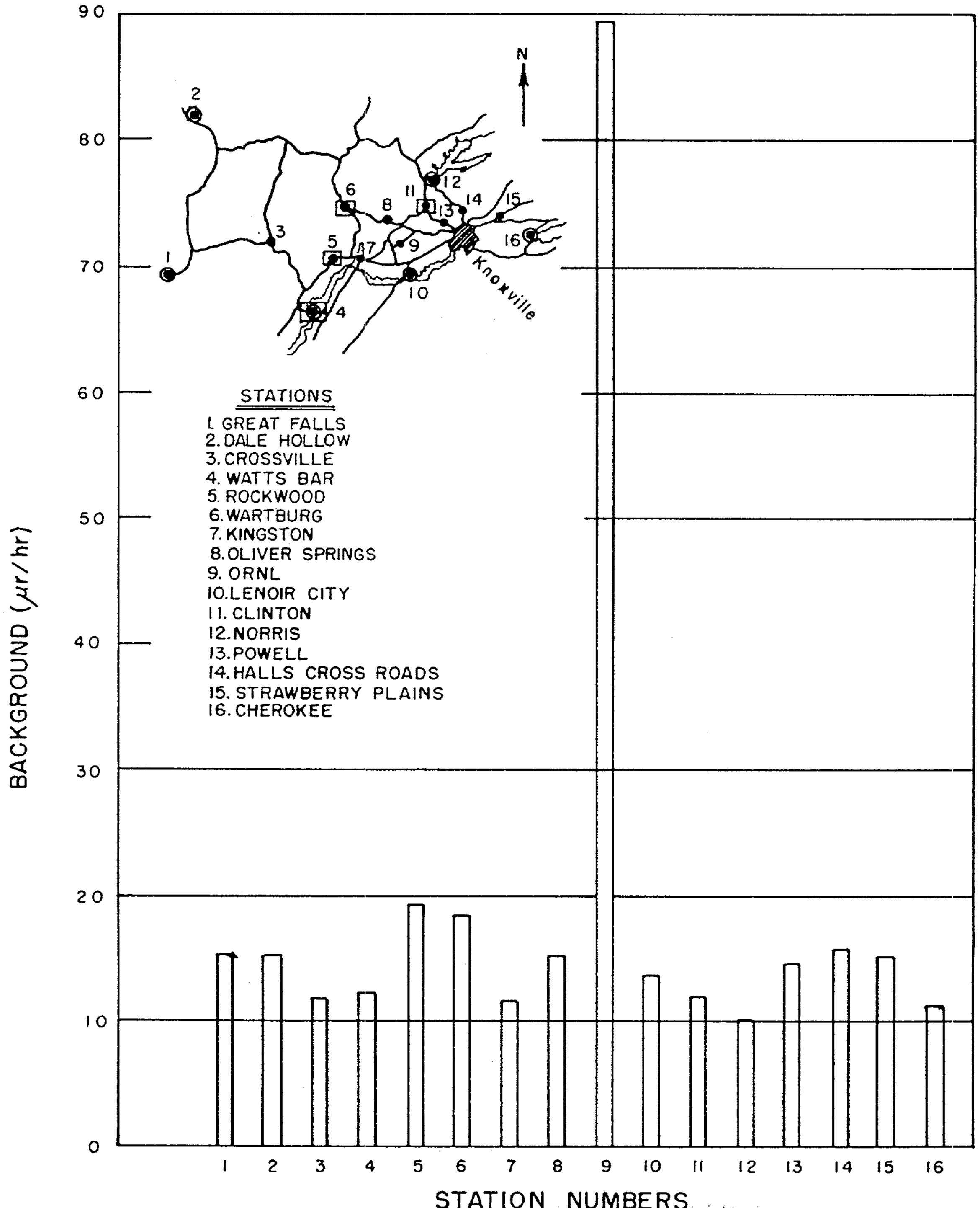

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Fig. 14. Radiation Measurements Taken during the 4th Quarter of 1961 3 ft. above the Ground Surface out to Distances of 75 Miles from ORNL.

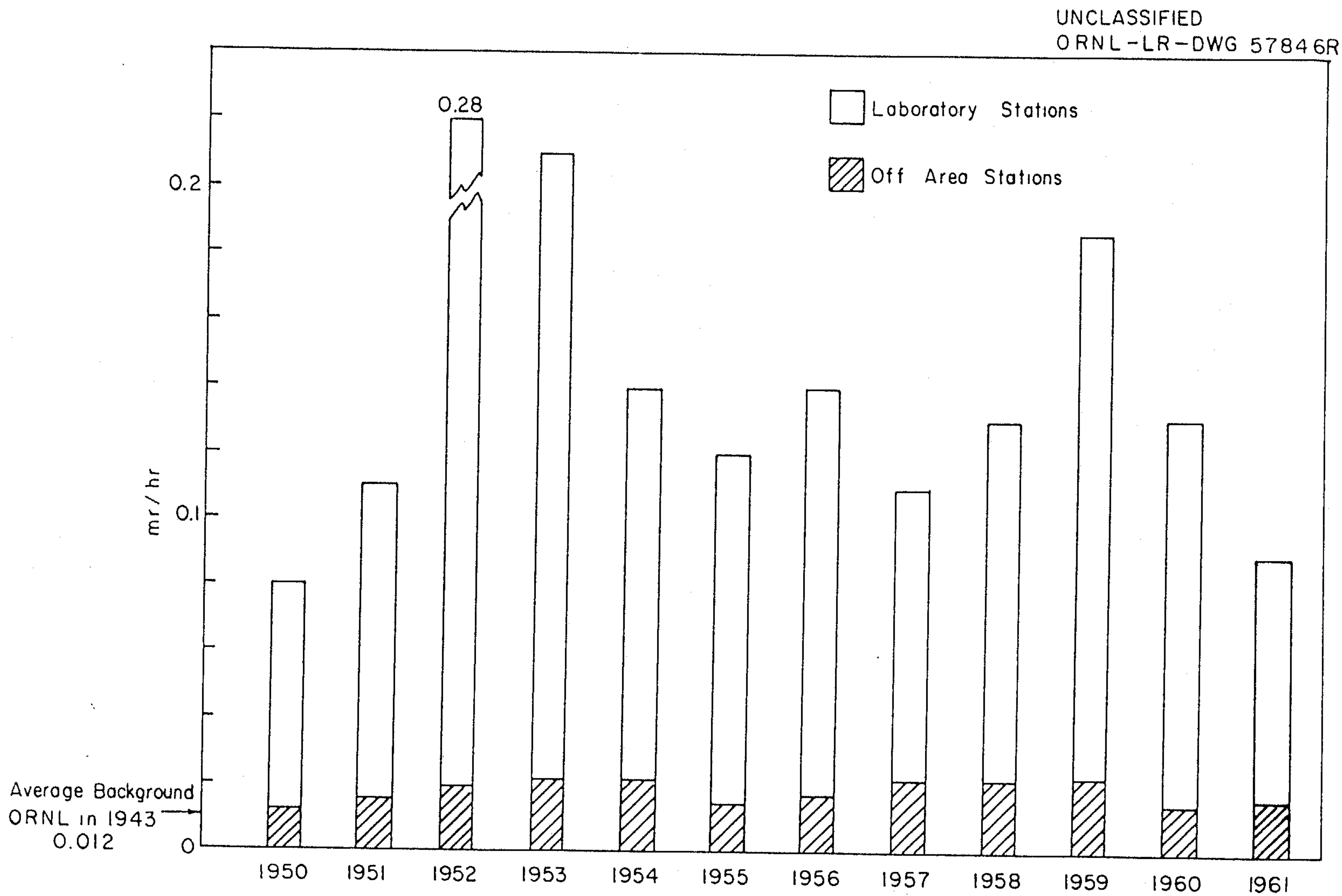

Fig. 15. Radiation Measurements Taken 3 ft Above the Ground Surface at ORNL Compared with Like Measurements Taken Elsewhere Within the AEC Controlled Area for the Years 1950-1961.

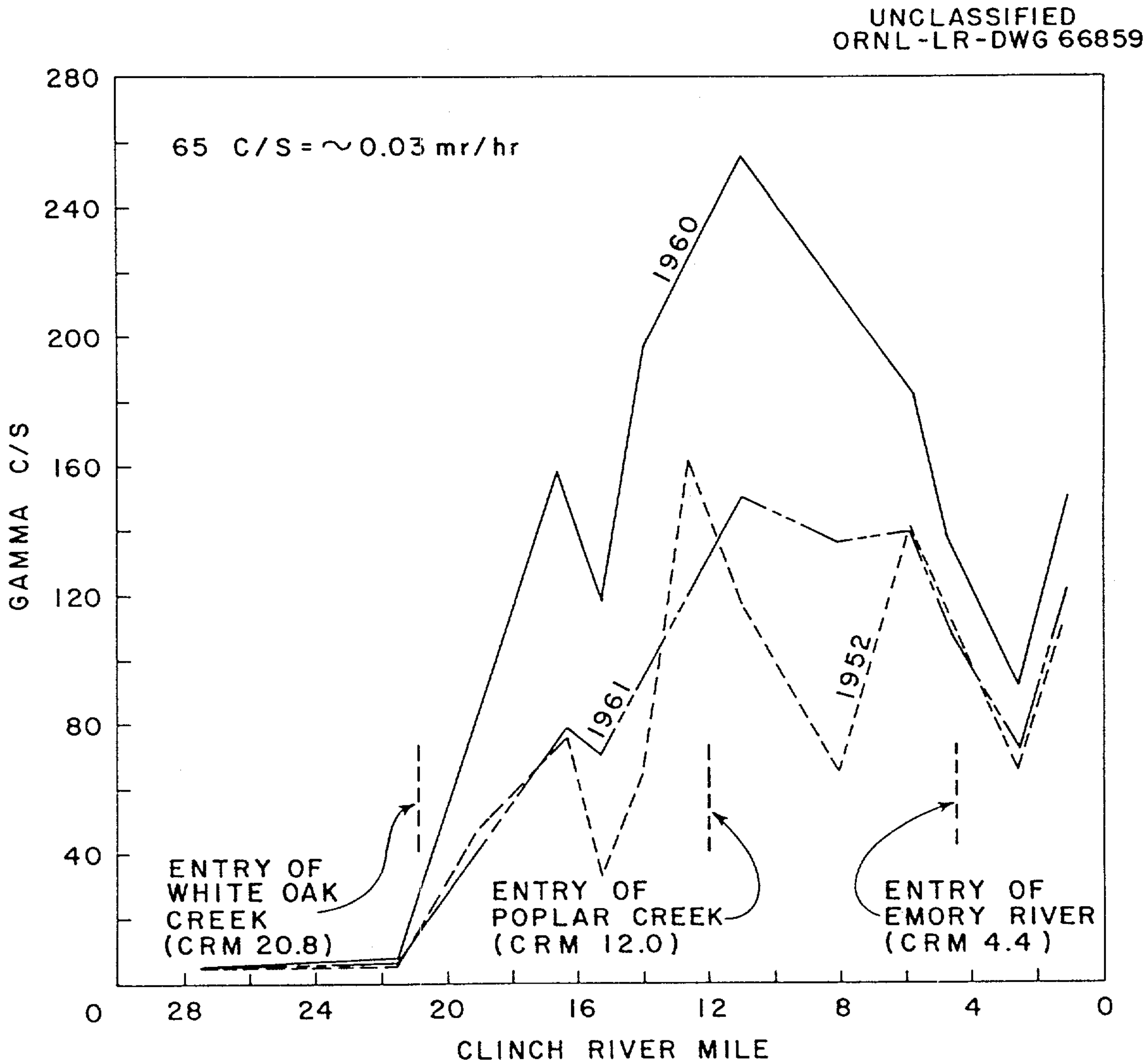

Fig. 16. Gamma Radiation Count at Surface of Clinch River Bottom Silt for the Years 1952, 1960, and 1961.

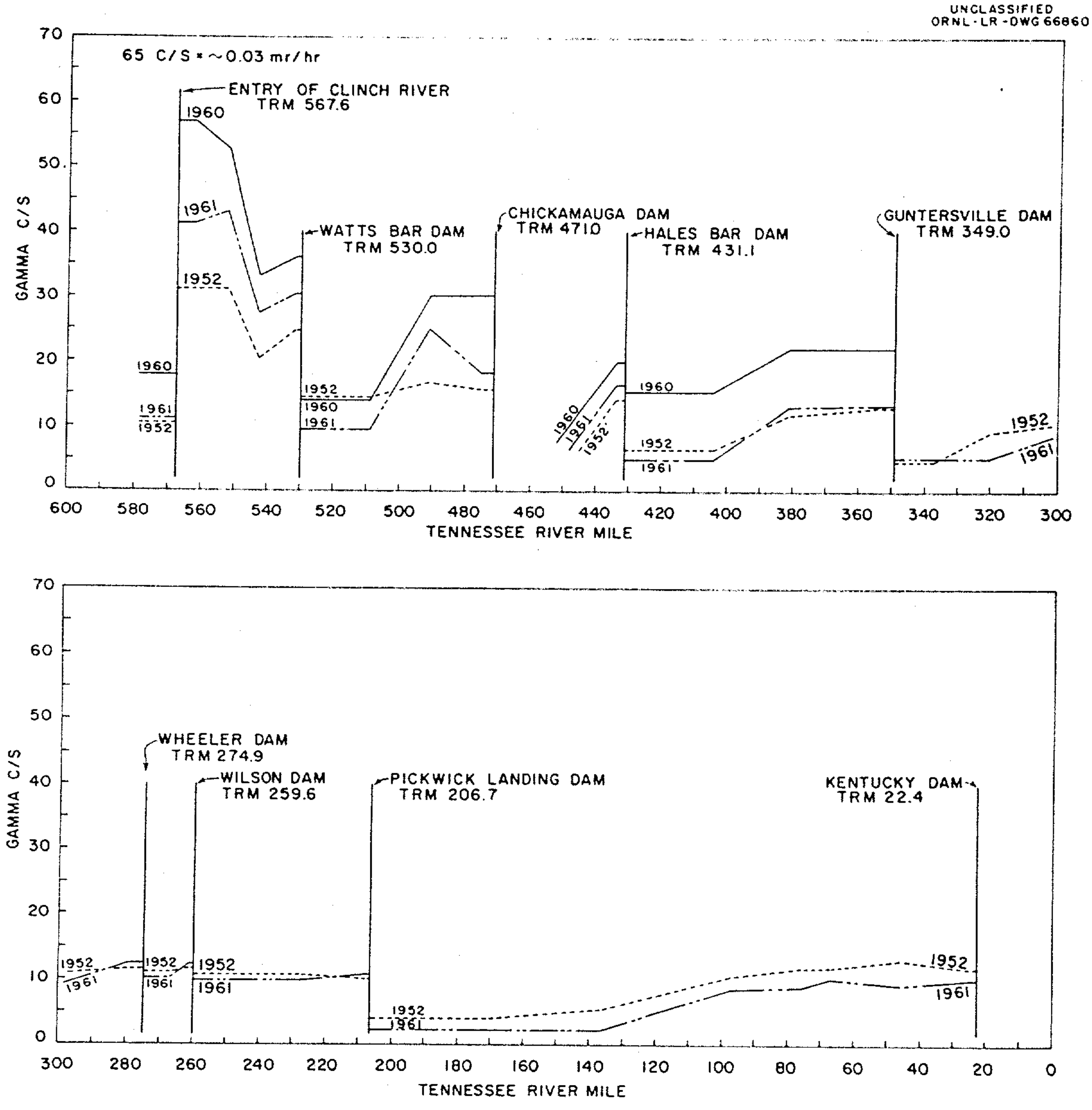

Fig. 17. Gamma Radiation Count at Surface of Tennessee River Bottom Silt for the Years 1952, 1960, and 1961.

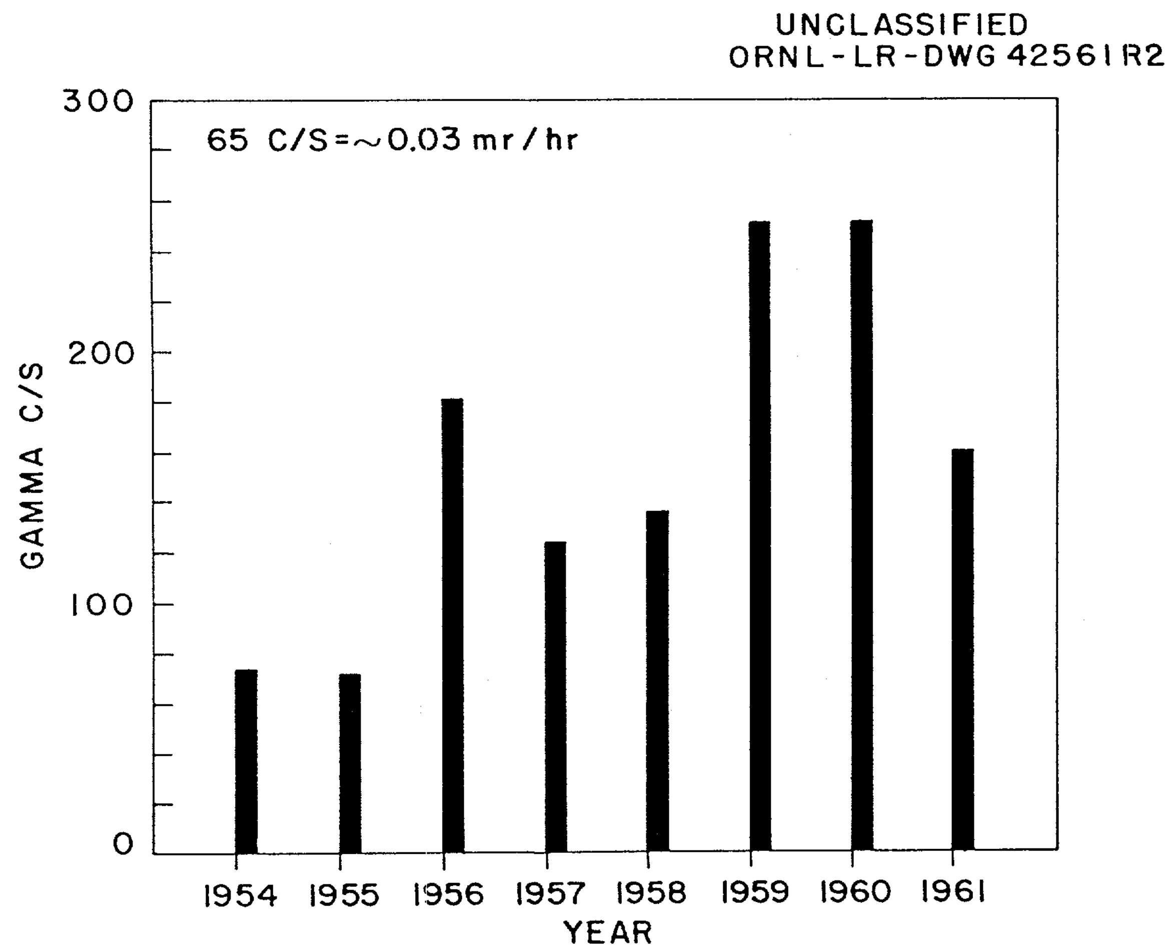

Fig. 18. Gamma Radiation Count across the Traverse of Maximum Contamination in Clinch River Bottom Silt for the Years 1954-1961.

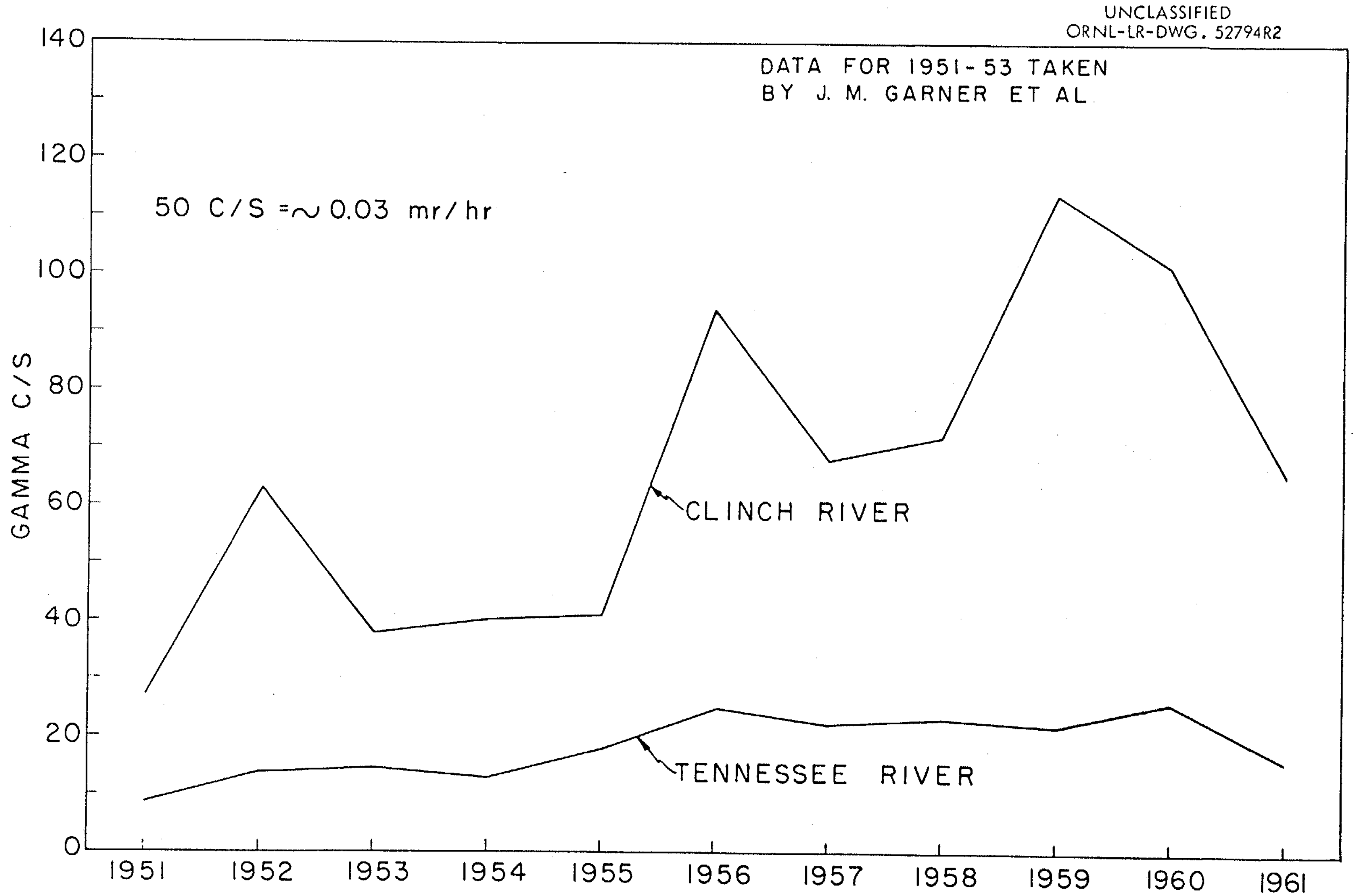

Fig. 19. Gamma Count at Surface of Bottom Silt in the Clinch and Tennessee Rivers for the Years 1951-1961.

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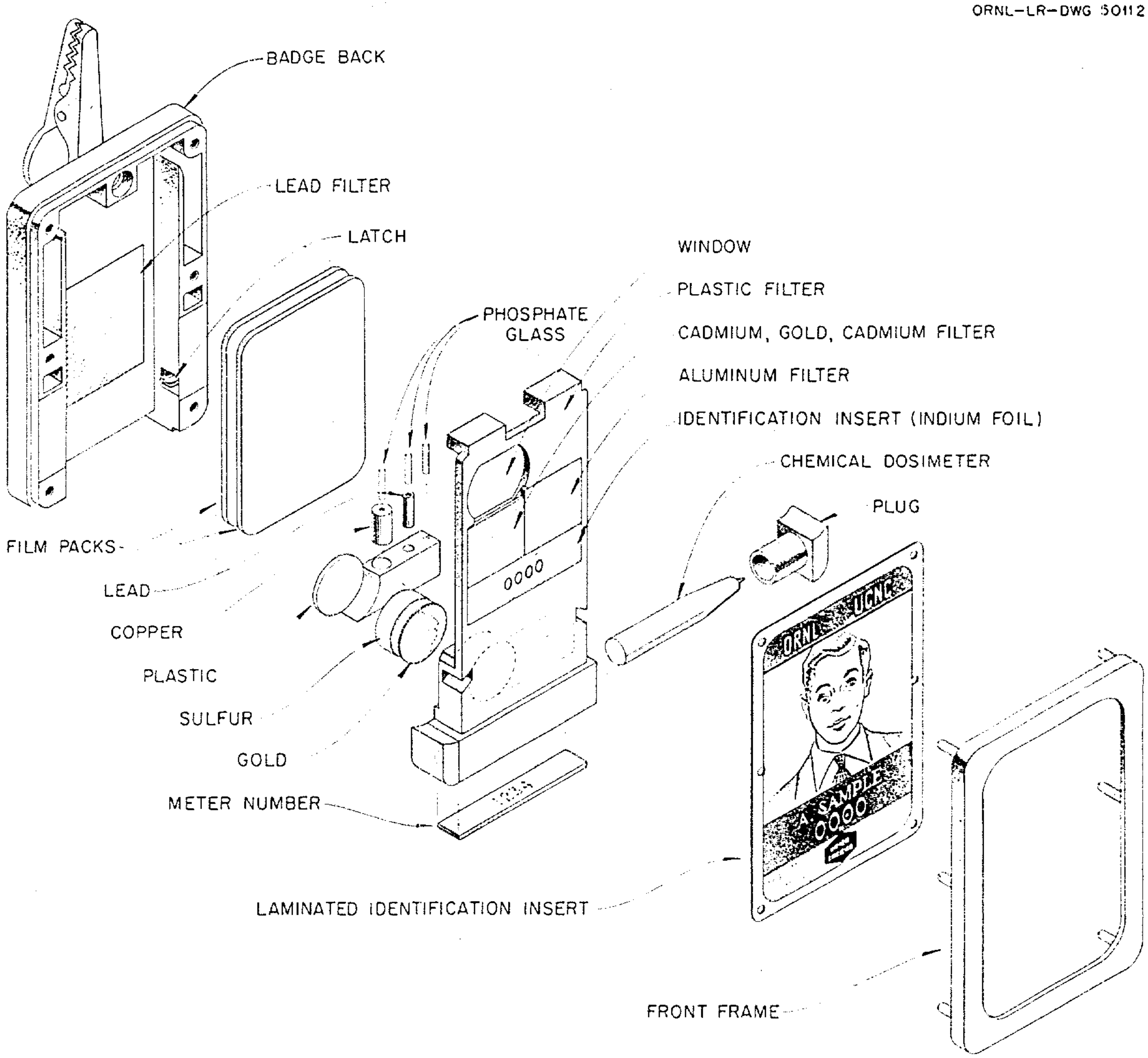

Fig. 20. ORNL Badge-Meter Model II.

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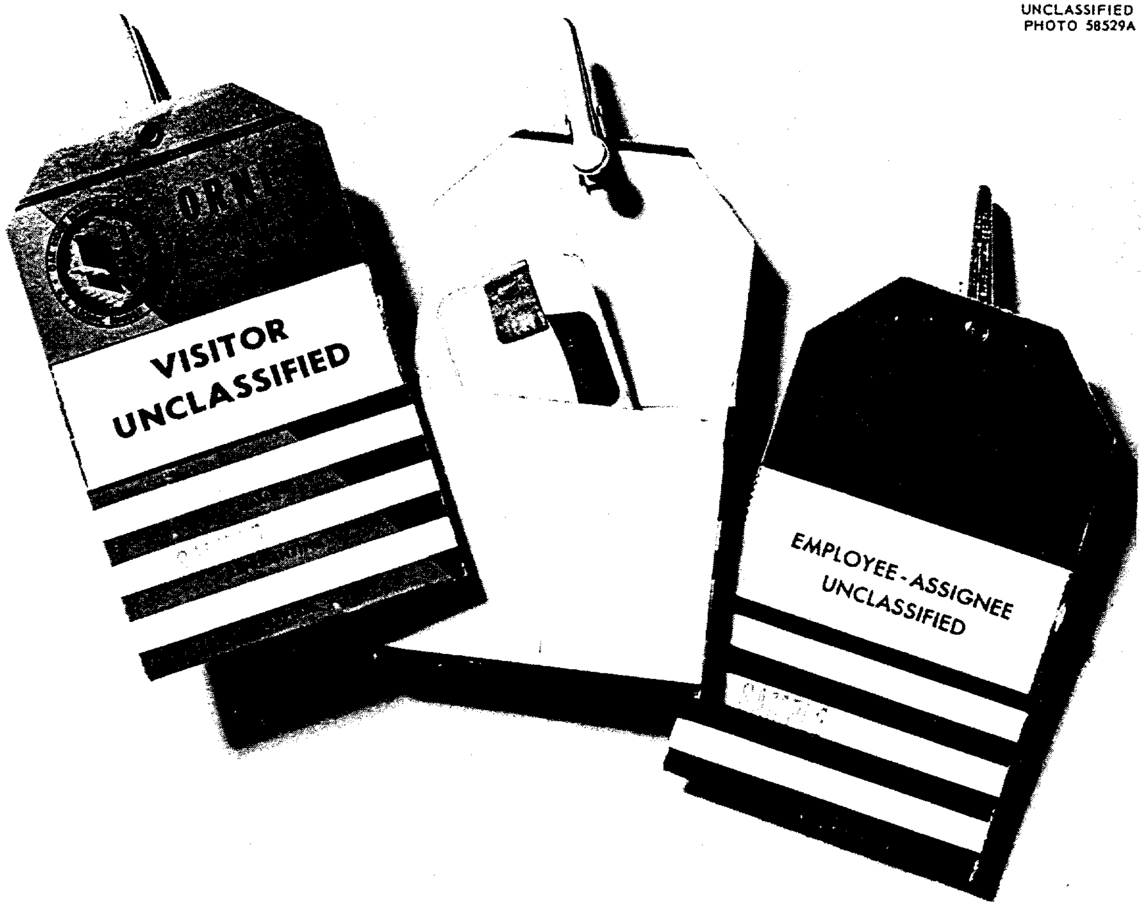
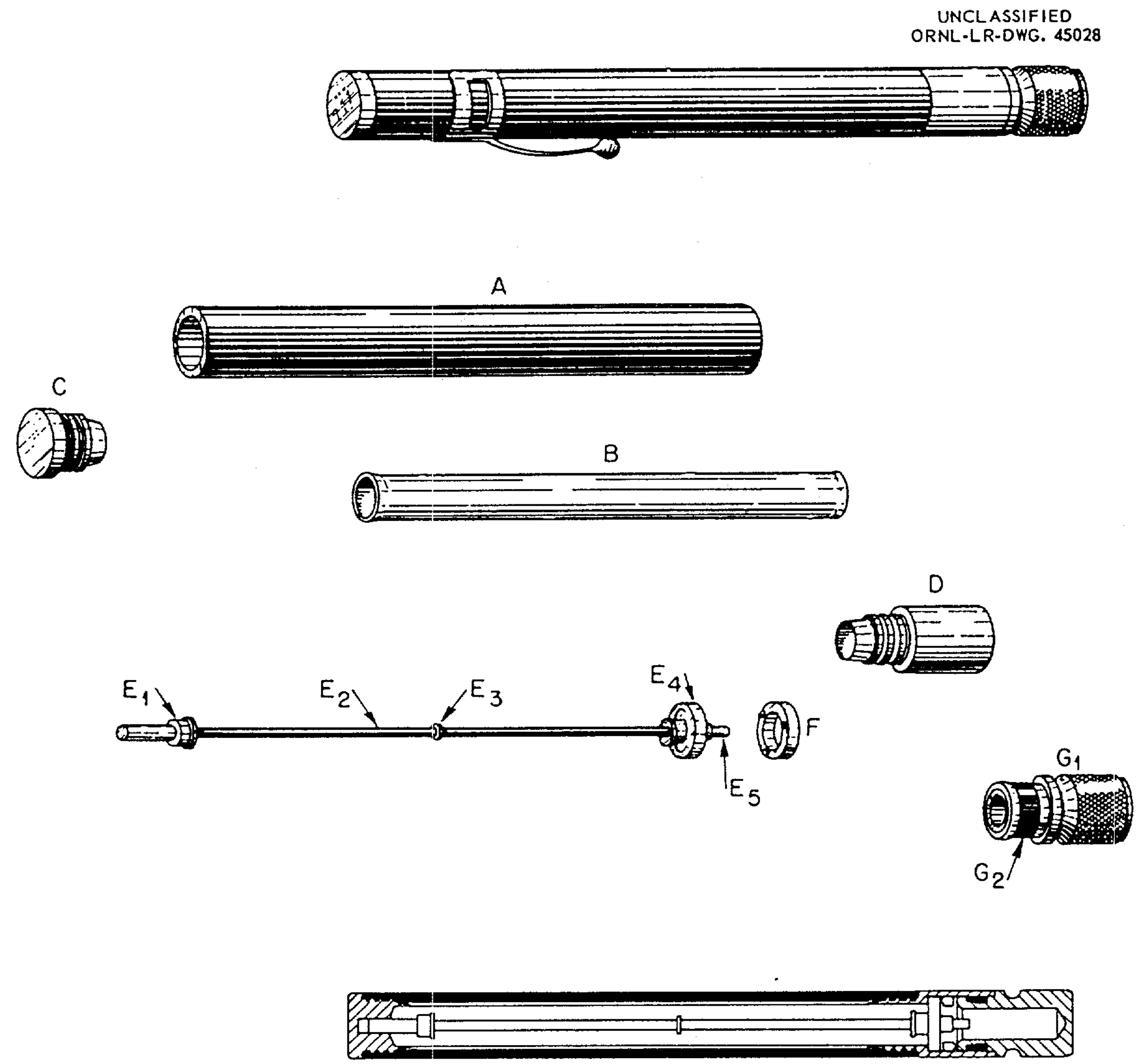


Fig. 21. Typical Temporary Security Passes Equipped with Monitoring Film.



A. LOW ATOMIC NUMBER WALL
B. GRAPHITE-COATED PAPER SHELL
C. ALUMINUM TERMINAL HEAD
D. ALUMINUM TERMINAL SLEEVE
E_1 POLYSTYRENE SUPPORT BUSHING
E_2 CENTRAL ELECTRODE, GRAPHITE COATED
E_3 POLYETHYLENE INSULATING WASHER
E_4 POLYSTYRENE FIXED BUSHING
E_5 ELECTRODE CONTACT
F. RETAINING RING
G_1 ALUMINUM BASE CAP
G_2 POLYETHYLENE FRICTION BUSHING

Fig. 22. Victoreen Pocket Meter, Model 352.

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